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Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 18.

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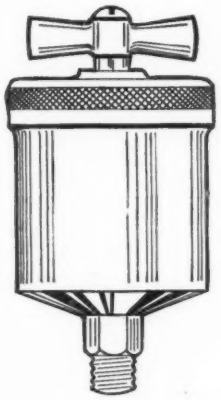

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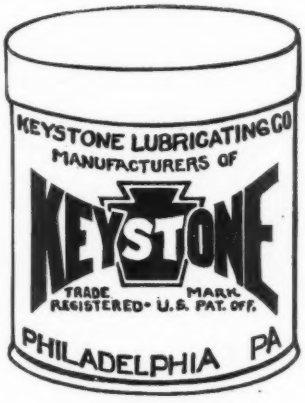

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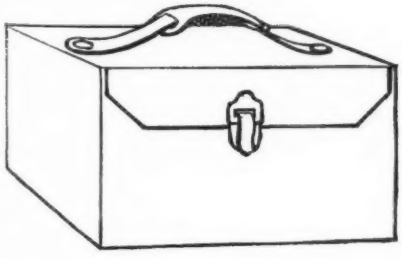

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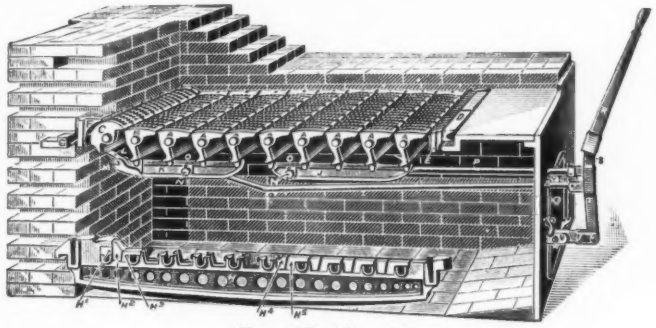

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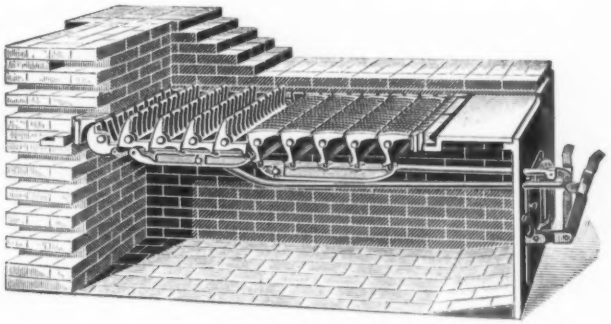

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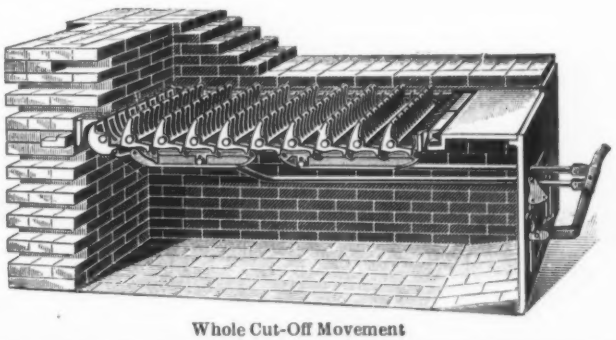

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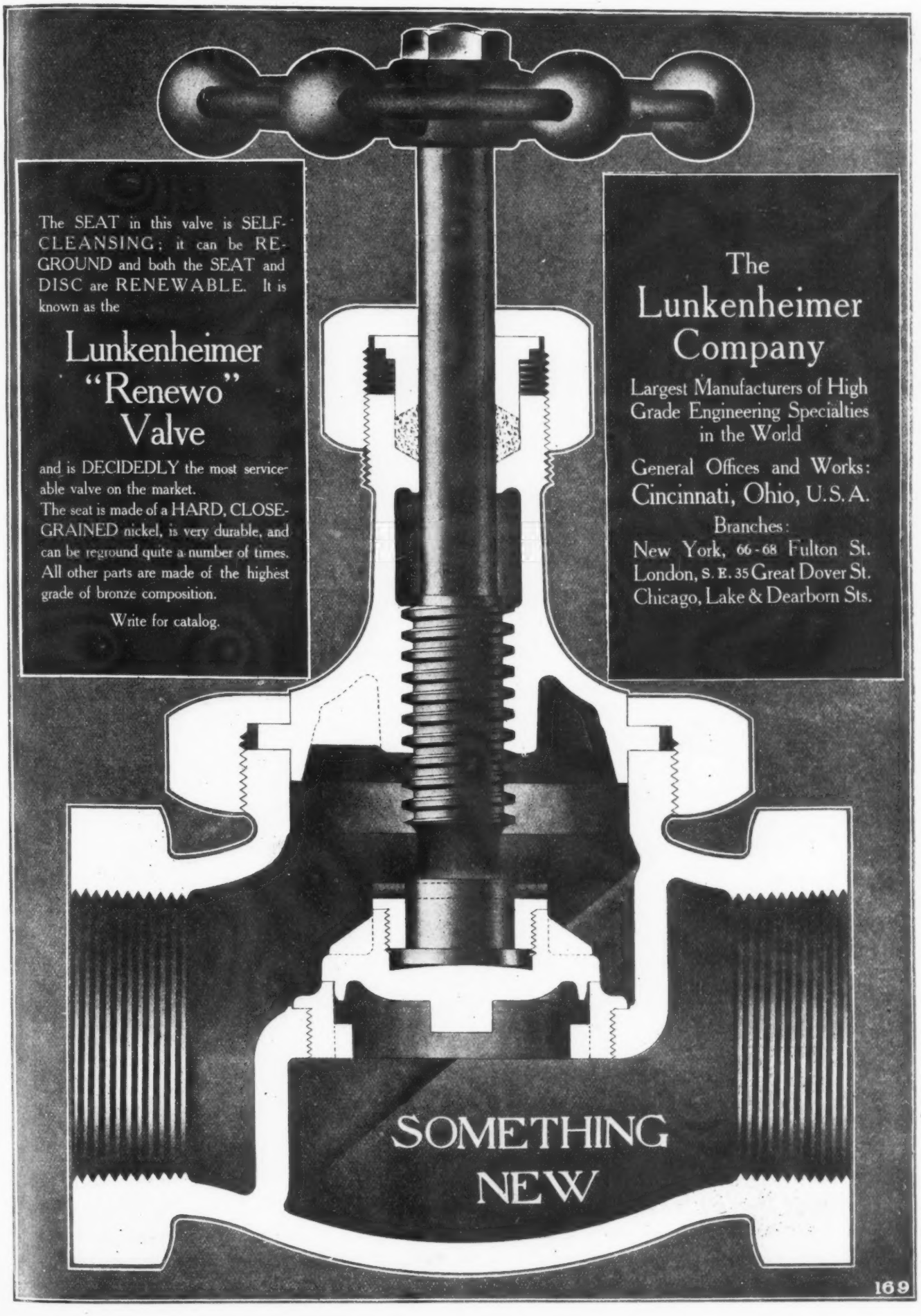
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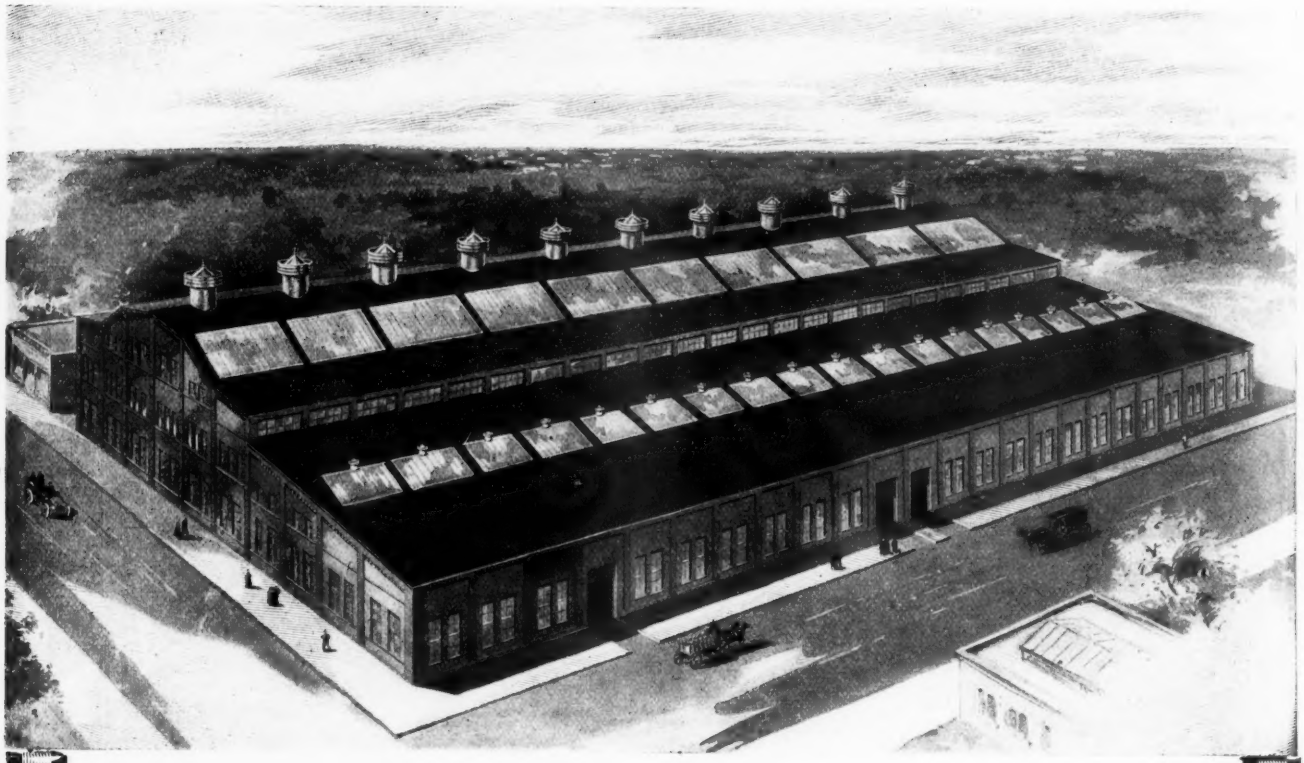

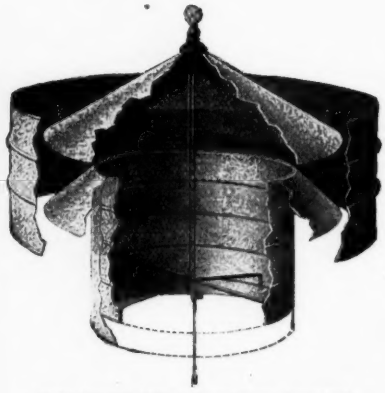

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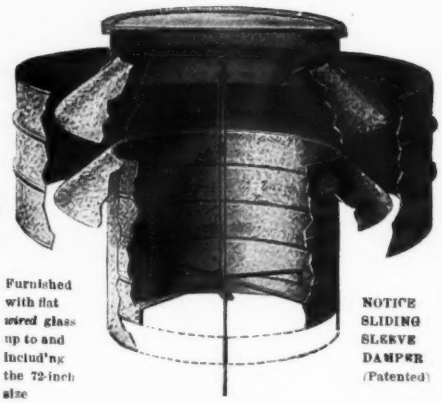

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Characteristics and Uses of Transformers

What to Guard Against in Their Selection and Care; Which Type to Use Ordinarily and How to Connect Them Up Clearly Explained

BY R. H. FENKHAUSEN

Commercial transformers are of two general styles, the "core" and the "shell" types, both of which may be obtained in either single-phase or three-phase units. The core type, Fig. 1, has a rectangular laminated core, on the long limbs of which

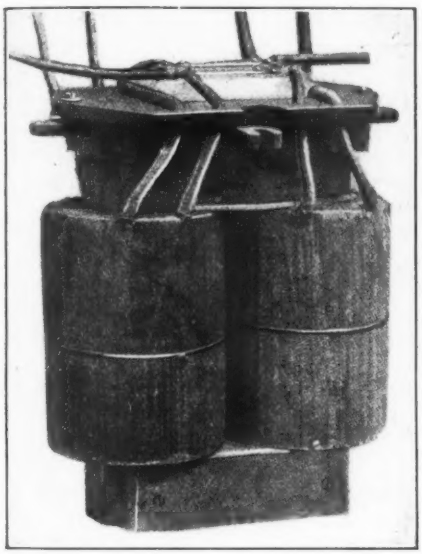


FIG. 1. CORE-TYPE TRANSFORMER

the windings are placed. The shell type, Fig. 2, consists of a laminated box or shell by which the windings are almost completely inclosed.

All transformers except some of those in use at stations are cooled by being submerged in oil, which also serves as additional insulation and tends to heal any small puncture. At stations the transformers may be oil-cooled, water-cooled, or air-cooled. The water-cooled type is simply an oil-filled transformer with pipe coils submerged in the oil, water being circulated through the pipe coils. The air-cooled type is subjected to continuous air blast from a fan.

Transformer Characteristics

Transformer losses are of two kinds, the iron or "core" loss, due to the rapid reversals of the magnetic flux in the core, and which goes on as long as the primary winding is connected to the supply line, and the copper loss, which is the loss in the windings and which varies with the load, being practically nothing at no load and maximum at full load.

As a general rule, a transformer which has a very small iron loss has a large copper loss, and *vice versa*. Consequently, a transformer which has unusually close voltage regulation will usually have a high iron loss, because close regulation is obtained by making the resistances of the windings, and therefore the losses in them, very low. Unfortunately, in lighting service, where close voltage regulation is of paramount importance, the transformer is idle most of the time and therefore subject to constant high iron loss, with its bad effect on the "all-day" efficiency; while in power service, where regulation is of secondary importance, the load factor is much higher. Therefore a small station must use greater care in the selection of an efficient transformer for lighting than for power service.

All stock transformers are wound for some standard ratio, such as 10 to 1; but various leads are brought out by means of which ratios of 5, 10 and 20 to 1 may be obtained from one transformer. Fig.

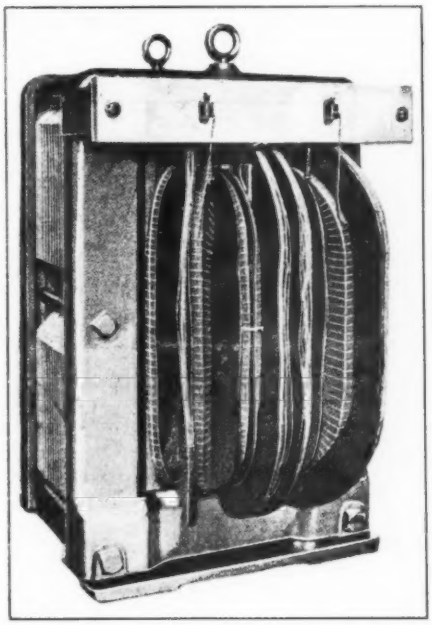


FIG. 2. SHELL-TYPE TRANSFORMER

4 shows the voltage combinations possible with a standard transformer. In selecting a core-type transformer for three-wire service one should be chosen with the secondary winding subdivided and cross-connected as shown in Fig. 5; otherwise, the voltage regulation will be extremely poor when the distribution system is out of balance.

What to Guard Against

Extreme care must be used to prevent

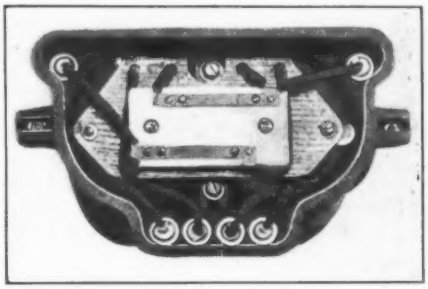


FIG. 3. COVER REMOVED, SHOWING TERMINAL BLOCKS

moisture from getting into a transformer, and if the oil has not been supplied by the transformer maker, it should be carefully tested for moisture. Even the oil sent with transformers sometimes takes up moisture, if care is not used. Many large companies replenish the oil in their transformers every year. If a transformer should be partly or wholly burned out, the oil will usually be carbonized and should be taken out and replaced by fresh oil.

Fuses should be used on both primary and secondary terminals of all transformers. The proper size may be found by dividing the capacity of the transformer in watts by the voltage of the winding to be fused, and using *the next larger standard size of fuse.*

The cases of all transformers should be permanently and thoroughly grounded and the neutral of a secondary three-wire system and one side of a two-wire system should be grounded; otherwise, a dangerous and possibly fatal shock may be received by anyone touching the secondary wiring if a ground should exist on the high-tension system. Except in railway work, it is not customary to ground any part of the system in which the voltage between any wire and the ground exceeds 250 volts. In any case where a ground is used it should be a good one; the false sense of security it gives makes a poor ground more dangerous than none at all. No better ground

than a water pipe can be secured, but in case there is not one within reach it is necessary to resort to a buried plate or a 1-inch pipe driven into the earth 6 or 8 feet, preferably in a lawn where it is likely to be kept moist.

The conductivity of ground connection should be tested and no ground showing more than one or two volts drop on a bank of ten lamps should be allowed to pass. The ground wire should be insulated so that, should the ground connection be accidentally broken, no harm can come to anyone touching the wire.

The regulation of transformers supplying inductive loads, such as motors, is not nearly so good as on a lamp load. It is therefore advisable to use separate transformers for lights and power except in cases where the motors constitute a very small part of the total load connected to any given transformer or set of transformers.

Better efficiency will be obtained by the use of one large transformer located centrally with respect to a secondary distributing network than from many small transformers scattered over the same area, within usual limits, not only because large units have better efficiency, but because the total transformer capacity will be considerably less, due to the fact that the maximum load will seldom come on at the same time at all places in a residence district. The saving in core loss will therefore more than pay interest on the extra cost of the secondary line wires.

Allowing for Capacity

In making allowance for transformer capacity, 25 per cent. of the connected load in residence districts and 75 per cent. for commercial circuits will usually be sufficient. In motor work one kilowatt of transformer capacity should be allowed for each horsepower of motors installed. In three-phase work, if the necessary capacity divided by three gives a standard size of transformer, three transformers should be used, as in case of a burnout on one transformer it may be cut out and the motor run at reduced load on the other two. However, two transformers, connected V-fashion, may be used if the use of three entails either overloading or greatly underloading the transformers. The disadvantage of using two transformers is that damage to one of them compels shutting down the motor circuit until another one can be put in.

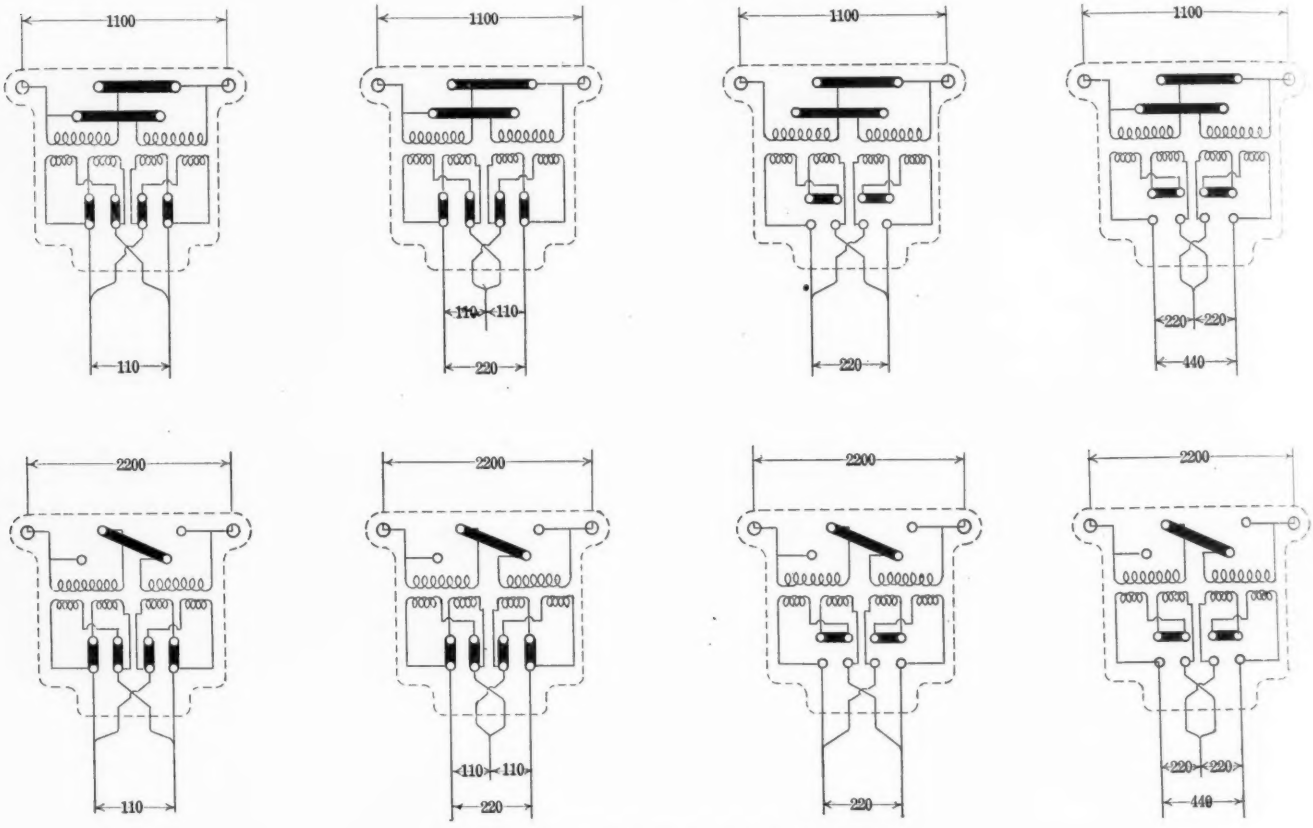


FIG. 4. CONNECTIONS OF STANDARD TRANSFORMERS

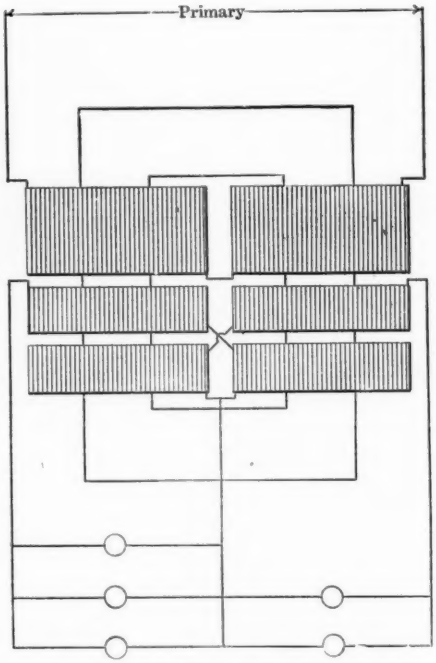


FIG. 5. CONNECTIONS OF SECONDARY WINDINGS FOR THREE-WIRE DISTRIBUTION

Fig. 6 shows transformer connections for two-phase circuits with both three and four wires; at *C* is shown the method of interconnecting a four-wire circuit to obtain 0.707 of the normal voltage between phases for starting motors.

It is sometimes necessary to operate three-phase motors from a two-phase primary circuit, or *vice versa*. Fig. 7 shows the Scott connection for this purpose. By the use of two standard transformers, one having a ratio of 9 to 1 and the other a ratio of 10 to 1, connected as shown, the secondary voltages will be slightly out of balance, but will be close enough for all practical purposes.

When rotary converters are supplied by separate transformers, which is usually the case, and the converter is supplying a three-wire direct-current system, the neutral wire of the direct-current system is connected to the neutral points of the transformer secondary windings, as indicated by Fig. 8.

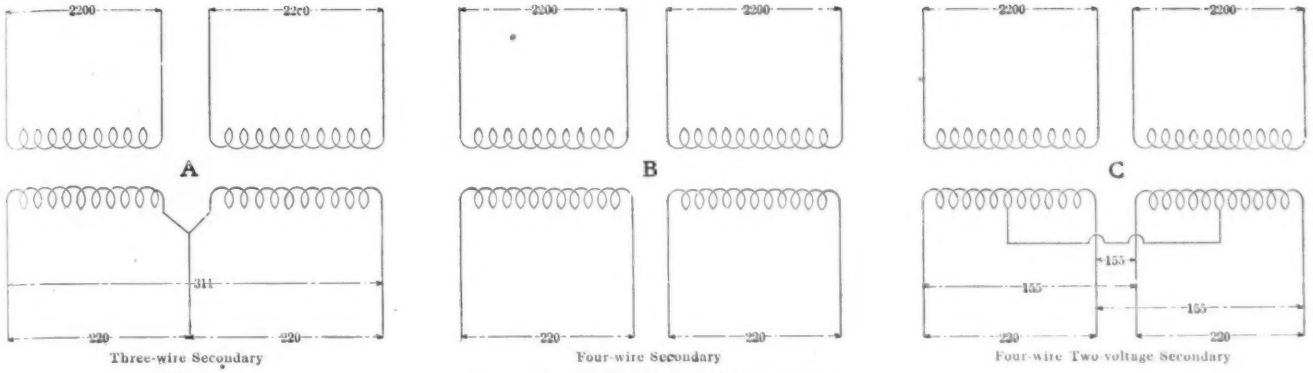


FIG. 6. TWO-PHASE CONNECTIONS

CONNECTIONS FOR THREE-PHASE WORK

There are several methods of connecting transformers for three-phase work, using either two or three transformers. Fig. 9 shows those commonly used and the resulting voltages. If the desired ratio of primary to secondary voltage cannot be obtained with standard transformer windings it can often be done by connecting the primaries in star and the secondaries in delta, or *vice versa*, as indicated in this set of diagrams. The former arrangement *divides* the normal voltage ratio by 1.732 and increases the current ratio correspondingly, and the latter *multiplies* the normal voltage ratio by 1.732 and decreases the current ratio correspondingly. The V, or open delta, and the T-connections are shown diagrammatically in Fig. 10. In using the V-connection it must be borne in mind that the combined capacity of the two transformers will be equal to only 86.6 per cent. of the sum of their individual capacities.

When the secondary windings of three transformers are star-connected, a fourth wire may be run from the neutral point and three-phase distribution effected by the four-wire system, as indicated by Fig. 11. The voltage between any main wire and the neutral will be 57 per cent. of the voltage between any two main wires. For general distribution this system is the best in many respects, requiring less copper in the line wires and possessing greater flexibility than any other. Three-phase 200-volt motors may be supplied from the main wires and 115-volt lamps connected between each of the three main wires and the neutral; if the lamp load is very nearly balanced the current flowing in the neutral wire will be very small, as in the case of the ordinary three-wire direct-current system.

PARALLEL OPERATION

When connecting transformers for parallel operation, tests should be made of all transformers, except where the transformers are of the same type and make, to ascertain if the ratio, regulation and other characteristics of the transformers are the same, as the connection in parallel of dis-

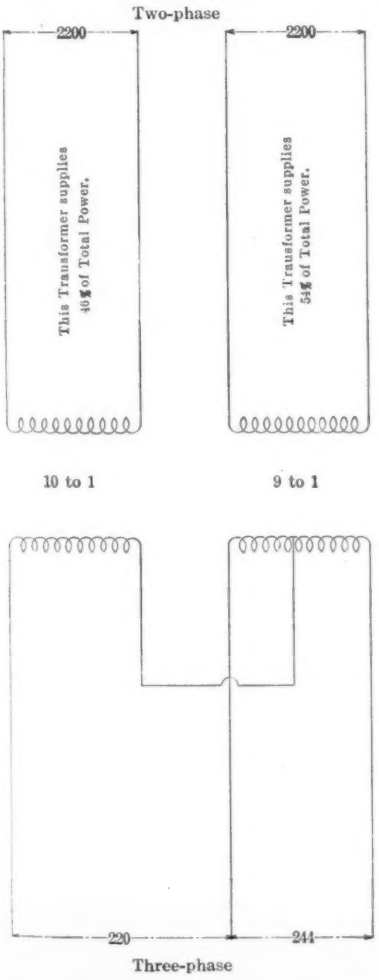


FIG. 7. TWO-PHASE-THREE-PHASE CONNECTIONS

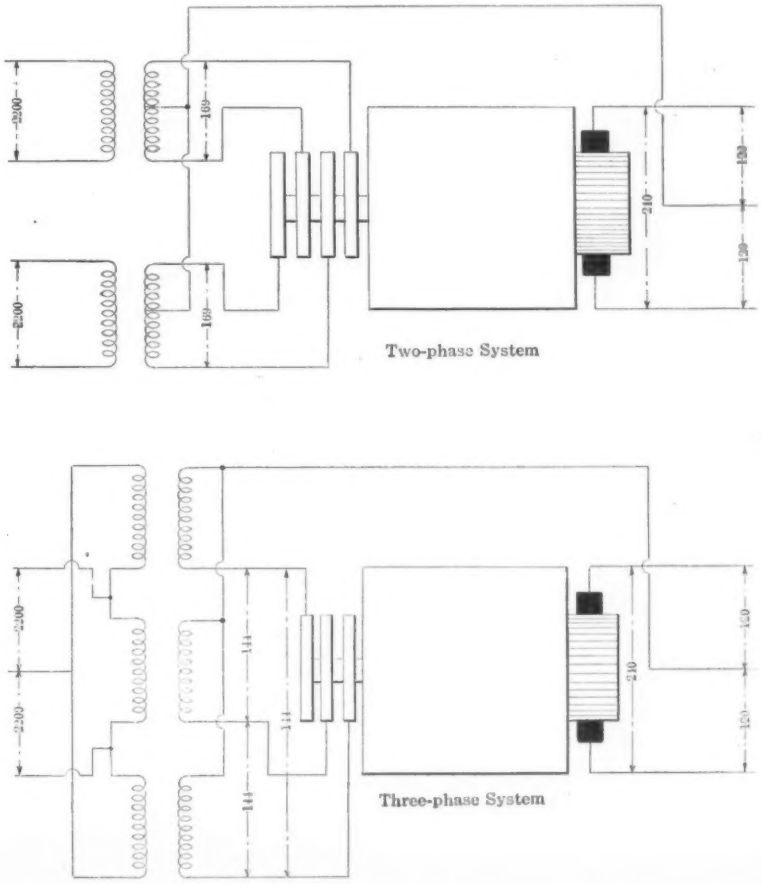


FIG. 8. CONNECTIONS FOR SUPPLYING THREE-WIRE DIRECT-CURRENT CIRCUITS THROUGH CONVERTERS

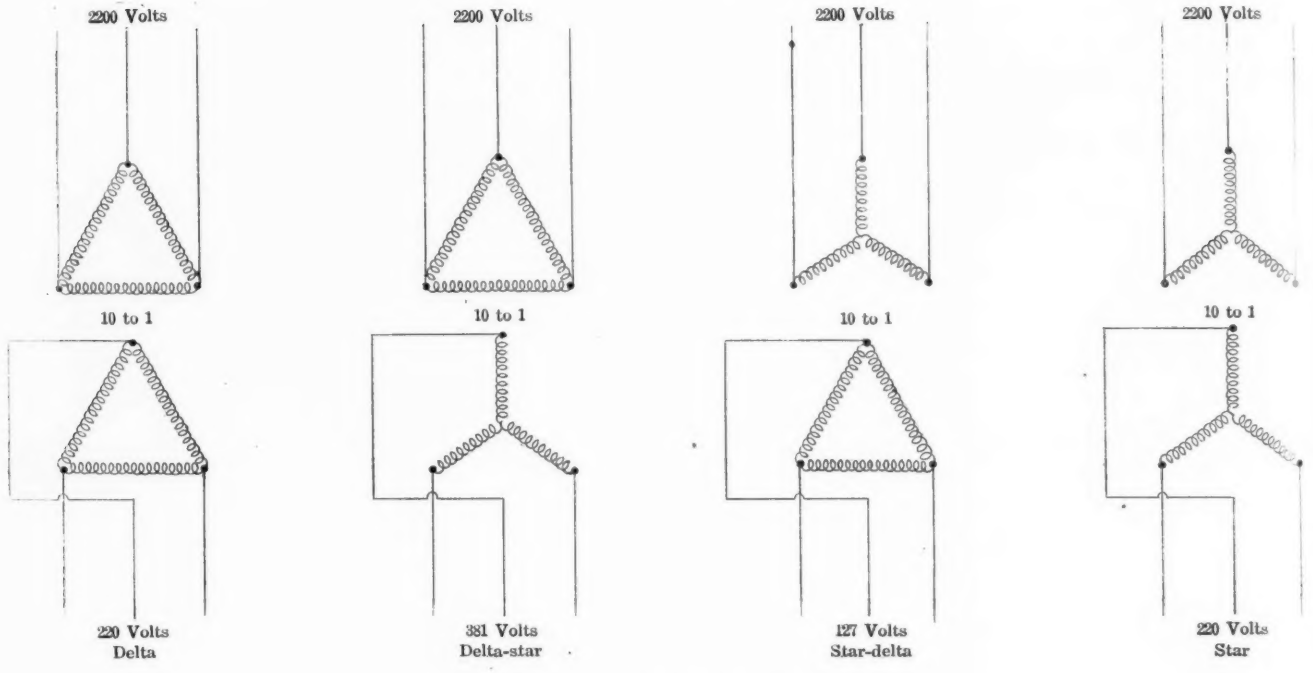


FIG. 9. THREE-PHASE CONNECTIONS

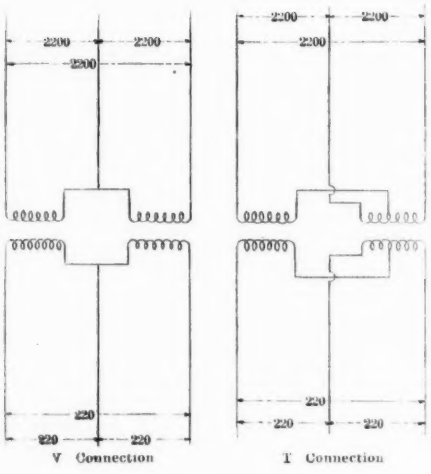


FIG. 10

similar transformers will result in heavy cross-currents and probably in burned-out coils. Even should everything test the same, the instantaneous polarity of the transformers should be determined before they are connected up, as the result of connecting one transformer unlike its mate would be equivalent to that produced by two transformers in series, on a dead short-circuit.

Among the special applications of transformers may be mentioned the booster shown in Fig. 12. Suppose a 2200-volt circuit carrying 100 kilowatts had a 10 per cent. line drop. By the use of a 10-kilowatt 10 to 1 transformer with its primary winding connected across the line and its secondary winding in series with it, the voltage at the far end may be boosted to the normal value of 2200. A booster transformer should be located in a substation or some place where there is an attendant to cut it out at times of light load and throw it in again during the heavy-load periods.

Another application, of the reverse nature to the booster, is to reduce the voltage on a feeder without affecting that of the station in general. This is accomplished by so connecting the "booster" that it opposes the line current instead of assisting it. The reversed booster is used during light loads, and during heavy loads it is disconnected and the full voltage left on the line.

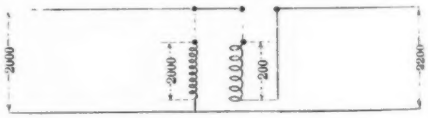


FIG. 12. BOOSTER CONNECTION

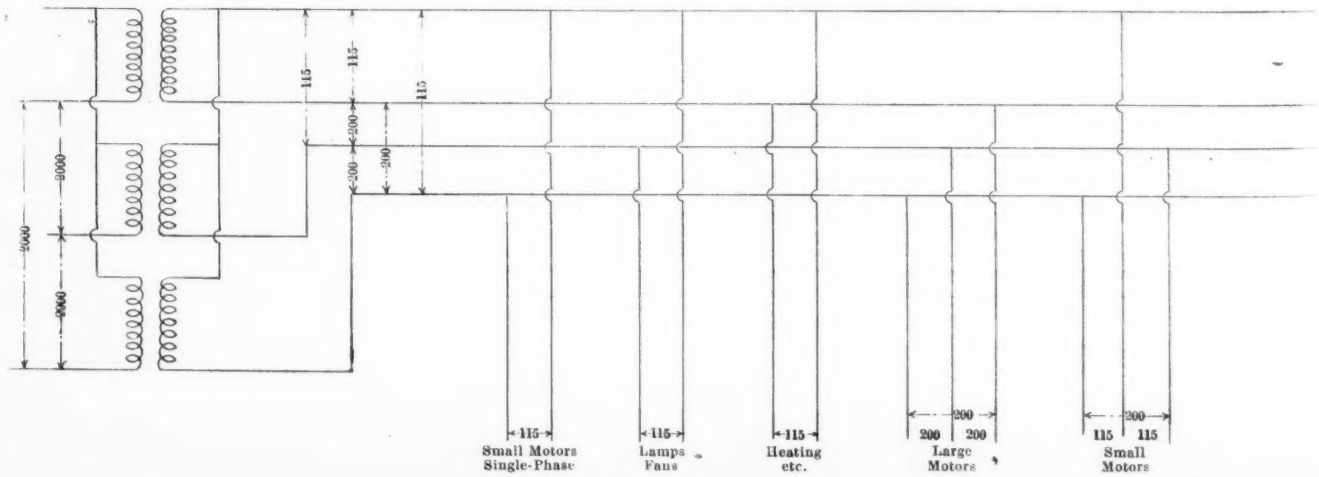


FIG. 11. FOUR-WIRE-THREE-PHASE DISTRIBUTION

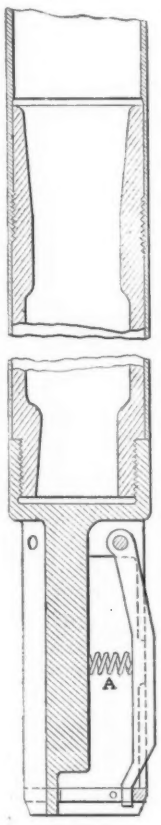
The Plunger Hydraulic Elevator

Automatic Stop Valves of the Otis Machine; Replacing Worn Shoes; How to Disconnect the Plunger; Care Observed in Handling Parts

BY WILLIAM BAXTER, JR.

Automatic-stop Valves

The automatic-stop valves of the Otis plunger elevators are very similar to the main valves used with hand-rope control, and are taken out of the valve cylinder through the upper end in the same way as the latter. These valves have the cup



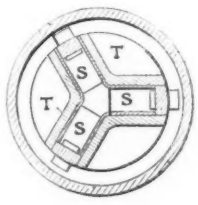


FIG. 274

packings set in the right position when first installed and have no means for adjusting their position because such adjustment is not necessary. In repacking them all that is necessary is to use cups of the same shape as the original cups. All that has been said in relation to the main valves applies equally well to the automatic-stop valves.

The only point that remains to be considered in connection with the Otis plunger elevator is the lower end of the plunger. As the cylinder is from 2 to 3 inches larger in diameter than the plunger, the lower end of the latter has to be guided so that it may not wobble around when the elevator is in motion. The guides used for this purpose are shoes made of hard brass, their shape being shown in Fig. 274. In some cases three shoes are used, as shown in this drawing, the shoes being spaced equally around the circle. The lower part of Fig. 274 is a horizontal section through the lower end of the plunger, showing the position of the three shoes *S*, as well as the sides *T*, of the slots within which they move. In some plungers four shoes are provided, as shown in Fig. 275. In both arrangements the shoes are pivoted at the upper ends and are held from swinging out too far by a stop ring at the lower end, as shown in both drawings. The cylinder itself prevents the shoes from spreading out beyond a certain point, but if the retaining ring were not provided at the lower end the plunger would not be held central unless all the springs *A* were of equal tension.

As the shoes slide against the wall of the cylinder they wear out and from time to time have to be replaced. The rapidity with which they wear out depends on several things, such as the character of the cylinder surface, the straightness of the cylinder, the hardness of the metal, etc. In the early days of plunger elevators the lengths of pipe that form the cylinder were put together in the same way as a line of piping so that the joints presented the appearance illustrated in Fig. 276, which represents a section through one side of the cylinder at a joint. With a joint of this type the shoes will wear out rapidly, as the edges *a a* cut them away. This, however, is not the only objection to such cheap construction, for the constant passing of the shoes across the joints results in wearing away the edges *a a*, so that in time the cylinder is enlarged at this point, with the result that when the plunger end passes it it swings from side to side. All plunger cylinders are put together now with great care, the ends of the pipes being turned true in a lathe and screwed into the coupling sleeves until the ends come together as is shown in Fig. 277. Even with this construction, however, there is a possibility of having uneven surfaces at the joints, because the thread may not be central with the pipe, in which case the metal will be thicker on one side than the other, and if the thin part of one pipe comes opposite the thick part of the other, the result will be as shown in Fig. 278, and thus a cutting edge will be formed that will cause the shoe to wear away faster than if it rubbed against a smooth surface. The life of these shoes is therefore very

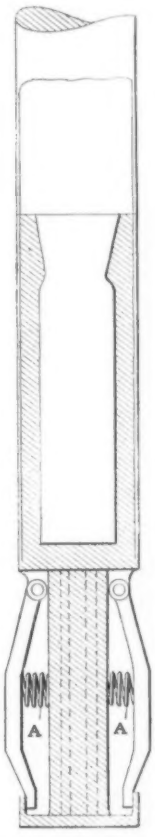


FIG. 275

variable, and according to the opinion of those who have had the greatest experience with plunger elevators may range all the way from five or six years down to as many months.

Replacing Worn Shoes

When the shoes wear out to such an extent that they do not all touch the sides of the cylinder at the same time they must be replaced, and it is needless to say that to replace them it is necessary to draw the end of the plunger out of

the cylinder. There are two ways in which the end of the plunger may be drawn out of the cylinder; one is by lifting the car and plunger high enough to raise the lower end of the plunger above the top of the cylinder. This can be done in some cases where the overhead beams are high enough, but in most buildings if the car is raised as far as it can be the end of the plunger will still be within the cylinder. In such case the only way to get the end out is by disconnecting the plunger at one of the joints and then lifting the lower portion.

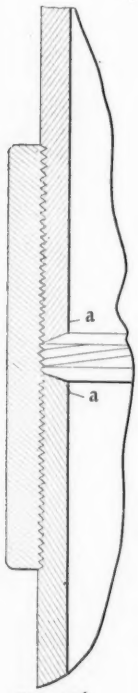


FIG. 276

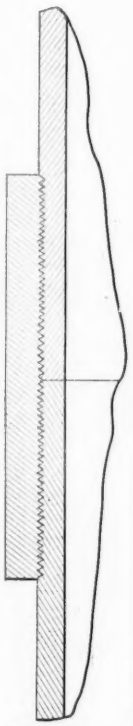


FIG. 277

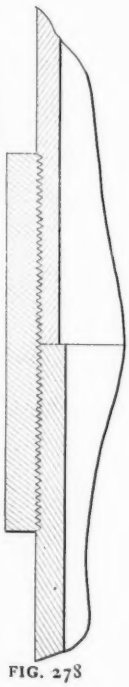


FIG. 278

The first thing to do in either case is to run the car up as far as the pressure of the water will carry it. If the plunger can be lifted out whole, the car is made fast to the overhead beams by means of strong ropes that are abundantly able to hold the load. Next a powerful differential chain block is put in position to lift the car, being secured to the overhead framing and to the top car frame. The water is then shut off from the cylinder by closing the hand valves in the supply and discharge pipes, and the water in the valves and piping is drained if these are above the top of the cylinder, but not otherwise. Having done this, the stuffing-box casting is unscrewed from the top of the cylinder casting, and is made fast to the plunger so that it will not slide down when the plunger is raised. All this being done, the car and plunger are raised until the end of the latter comes out of the cylinder. As the car is raised, the slack in the ropes that hold it to the overhead beams is taken up so that if the hoisting tackle should break, the car would drop only a few inches.

When the end of the plunger is raised above the cylinder, if it is found that all the shoes are not badly worn they need not all be replaced, but as their cost is not great, and the trouble of replacing them is considerable, it is wise to not be too economical; hence, unless the wear is only trivial they should be discarded. After the new shoes are put in place and the pins and springs set securely in position so that they cannot work out, the plunger is lowered into the cylinder until the stuffing-box casting rests on the top of the cylinder casting. Then the bolts are put in and screwed up so as to make a tight joint. The next thing to do is to remove entirely the ropes that hold the car to the overhead beams and lower the chain tackle until it slacks up, which shows that the plunger is resting on the water in the cylinder. The tackle is then removed and the valves in the supply and discharge pipes are opened and the elevator is ready to run. After it starts up, examine the joint between the stuffing box and top of cylinder to see if it is tight; if it is not, tighten the bolts, and if this does not make it tight, the car will have to be fastened up to the overhead beams again and the water turned off so as to loosen the bolts, separate the joint, clean it out and make it over again, using more care than before so as to be surer of making a good job of it.

To Disconnect the Plunger

When the distance between the top of the car and the overhead beams is not sufficient to lift the car high enough to draw the lower end of the plunger out of the cylinder, and it becomes necessary to disconnect the plunger at one of the joints, the work is done as follows: After the car is run up to the top floor and made fast to the overhead beams, the water is shut off. The next step is to place wooden clamps on the plunger above and below the bottom joint, which is at the top of the first length of pipe. The illustration, Fig. 279, shows the position of these clamps, which must be made to fit the plunger accurately in order not to spring it out of shape. The clamps *A* are to be made long enough to reach from one side of the elevator well to the other, so that they may be firmly secured to the car guides, or some other suitable support. The object of these clamps is to hold the upper part of the plunger from turning so that when the lower joint is unscrewed the upper ones may not be disturbed. It is necessary that the clamp *A* be so tight that it cannot turn when the pipe is unscrewed. To make sure that it does not turn, make a chalk mark on

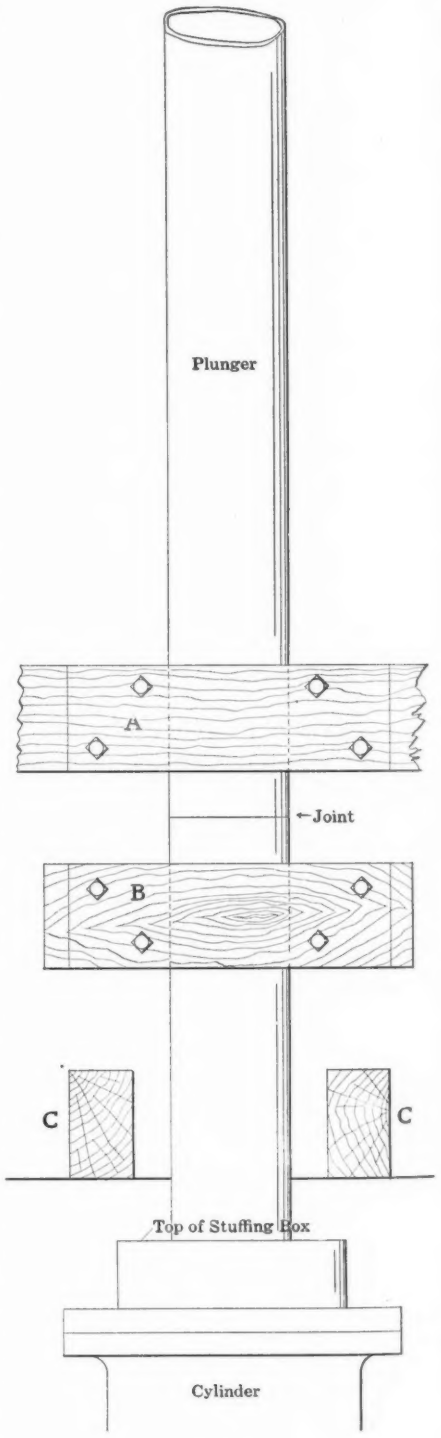


FIG. 279

the plunger and one on the clamp opposite and watch them when the clamp *B* is turned. Before starting to turn the latter clamp, look at the joint and see if it is marked to show the position of the two parts when tightly screwed up. If not, make one with a cold chisel that has

a sharp, straight edge. Then turn the clamp *B* to unscrew the pipe. If it sticks at first, it can be easily started by rapping the clamp rather hard with a large hammer or a sledge while pulling on the clamp.

After the pipe has been worked off, say ¾ of an inch, place under the clamp *B* supports as shown at *C C*, Fig. 279, so that it may not be able to drop when nearly loose and thereby strip the last few threads of the pipe or the coupling. The supports *C C* are here shown a considerable distance below the clamp *B*, but they should be held against it to carry the weight and relieve the screw thread from strain. It might be supposed that this is not necessary as the buoyancy of the plunger, together with the friction of the stuffing, might be sufficient to hold the weight; but it is not safe to depend on this, because the water displaced only weighs about 14 pounds per running foot of the plunger while the lower end of the latter, on account of the weight of the lower casting, will probably weigh 30 pounds per foot. After the joint has been entirely unscrewed, the stuffing-box casting is unscrewed and then the lower section of the plunger is lifted out of the cylinder, the upper portion of the plunger being sprung to one side to make room. Unless the elevator is of very low lift, say less than 100 feet, no damage will be done to the plunger if it is sprung over to the side of the well, as this much bend is far within the elastic limit of the metal.

After the old shoes are removed the lower section of the plunger is put back in the cylinder and lowered until the end of the upper part can be brought into alinement with it; the thread is then covered with red lead for about half its length to make a water-tight joint, and the sections are screwed together a trifle farther than originally. On the last turn, when the chisel marks come in line, the two parts will be in their original relation, but the joint will not be as tight as before, because every time a screwed joint is taken apart and put together, the metal wears a trifle, leaving room for slightly more "take-up" when tightening it "home."

In the foregoing methods of taking out the lower end of the plunger, the stuffing box is raised with the plunger. This is done because it would be likely to damage the packing if the guide shoes at the lower end of the plunger were pulled and pushed across it. The type of packing shown in Fig. 270 could stand this treatment, but hemp packing could not.

When the lower end of the plunger is disconnected, care must be taken not to allow it to get away and drop into the cylinder. There is not a great deal of danger of such a thing happening, because if the clamp *B* is not removed the plunger end cannot drop. There is no reason for removing the clamp and every reason for keeping it in place, because it is an excellent point of attachment for the tackle used to pull the plunger end out of the cylinder. Notwithstanding all this, it is possible for something to occur

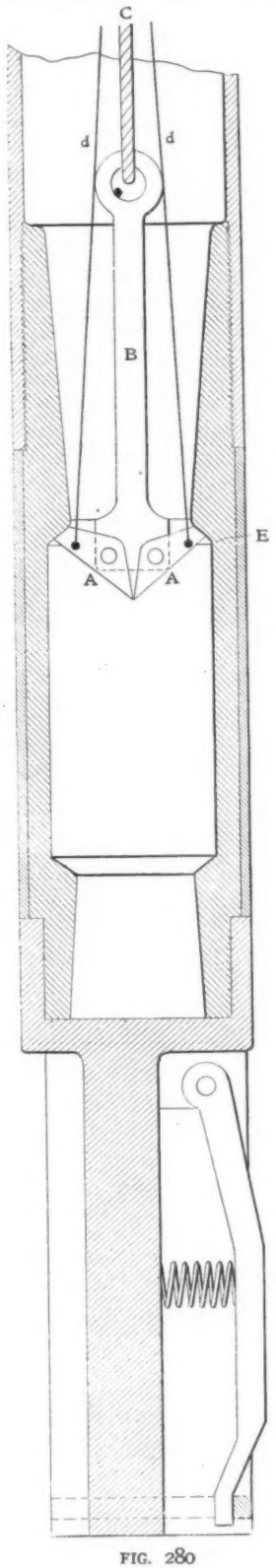


FIG. 280

that would cause the plunger end to get loose and slip down into the cylinder, and the possibility must be kept in mind. If one should ever get into such a scrape, he could get out of it by using a grapple of the type shown in Fig. 280, which consists of dogs *A A* mounted on the end of a rod *B* and arranged to swing out so as to catch against the under side of the shoulder *E* in the lower end casting of the plunger. After the plunger is raised out of the cylinder and made fast, the grapple can be taken out by pulling up the cords *d d*, thereby drawing the ends of the dogs into a position where they cannot catch against the shoulder *E*.

Value of Flue Gas Analysis

In a recent boiler-plant test made by the coal department of the Arthur D. Little Laboratory, Boston, Mass., the loss due to unburned gases from a thick, uneven fire was illustrated by an interesting occurrence in connection with the flue-gas analysis. The test showed the following relative conditions:

	1	2
Sample of gas taken	5:00 p.m.	5:30 p.m.
Carbon dioxide, CO_2, %	11.3	14.3
Oxygen, O, %	6.5	5.5
Carbon monoxide, CO, %	2.4	0.0
Nitrogen, N, %	79.8	80.2
Air excess, %	45	36
Temperature of flue gas, ° F.	545	700
Heat lost due to CO, %	9.7	
Heat lost due to increased temperature of flue gas, %		4.3

The first analysis shows a considerable amount of CO to be present. Before taking the next sample the CO started to burn through the passes of a 600-horsepower Aultman & Taylor boiler and the CO was being entirely consumed. The flue temperature rose 155 degrees on account of the burning of the CO through the passes of the boiler instead of in the furnace. There was no combustion chamber and the fire was so thick that it came close to the bottom row of tubes.

A number of points can be drawn from this instance:

(1) Had the boiler been set with an ample combustion chamber all gases would have been burned before coming in contact with the heating surface, resulting in a gas analysis like No. 2, but with a temperature corresponding to No. 1.

(2) The fire should not be carried so thick that CO will be formed, as it is very difficult to burn it all in a boiler furnace when once formed and the loss due to small percentages of CO is very great.

(3) The determination of CO_2 alone is not sufficient to determine whether the boiler is being properiy fired. In the case of No. 1 sample, a CO_2 indicator should have shown 11.3 per cent. of CO_2, which would ordinarily have been considered very good, but there would have been no indication that CO was present, while the loss due to it was as great as if the CO_2 had been only 7.5 per cent. with no CO.

A suction gas-engine outfit is being tried out on the old English warship "Rattler," with a view to determining the practicability of this type of propulsion.

Design of an English High-Speed Steam Engine

Ample Proportions, Absence of Unnecessary Weight, Automatic Adjustments, Careful Balancing and the Best of Materials Are Important

BY PHILIP BELLOWS

To the student of engineering it must seem somewhat strange that in England and America two distinct types of steam engine have been developed during the last 25 years for the important work of generating electricity. On this side the horizontal engine held almost undisputed sway until the advent of the steam turbine and the large gas engine. Throughout Britain, however, the type of prime mover most commonly met with, outside of the newcomers, is the modern type of vertical high-speed, inclosed, automatic engine, of which there are many well defined and distinct subdivisions. There are single-acting and double-acting engines, and there are forced-lubricating and splash-lubricating engines. It is the purpose of this article to consider an engine of the double-acting, splash-lubricating type.

It may be remarked, in passing, that the tendency in the old country has been to keep the size of the individual units within certain easily handled limits, so that it is the exception to find, even in very large installations, engines of more than 2000 to 2500 horsepower. Possibly one reason for this state of things is to be found in the smaller English loading-gage, which necessarily prevents the transportation of such large parts as are handled in this country. But a stronger reason no doubt lies in the fact that a small engine permits of more accurate workmanship and is, therefore, more suitable for the high speeds prevailing there. In general, the standard of design and workmanship is very high. Runs of 4, 6 or 8 months without stop or shut-down of any kind, whether for repairs, adjustment or any other reason, are not at all unknown.

The particular engine which I purpose to discuss in this article is known as the semi-superposed type. It may be characterized as a cross between a tandem and a side-by-side. This type has been developed by William Sisson at his works at Gloucester, England, and in its present form is a monument to his inventive genius, originality and persistence. The salient features of the design are numerous and noteworthy. A glance at Fig. 1 will indicate a few of them.

In general the frame of the engine is a box-like iron casting, whose sides taper inwardly. The crosshead guides are cast inside and integral with it, as are also the various brackets to carry the valve gear. In machining the frame, the seats for the main bearings are bored, after which a specially made jig is fitted to these seats and this jig takes the end of the boring-bar which is used to bore out the guides.

The crank-shaft, Fig. 2, is unusually liberal in its proportions; the crank-pins, instead of being set at 90 degrees, are set at 180 degrees, like those of a double-opposed gasolene engine. These crank-shafts have no middle bearing, hence the large size of the crank-pins and main journals. The forgings from which these cranks are turned out are noteworthy. They are made from billets of gun steel; in fact, they are samples of the steel from which the guns of the British navy are made. It is unusually hard and tough, with a tensile strength of from 95,000 to 100,000 pounds per square inch.

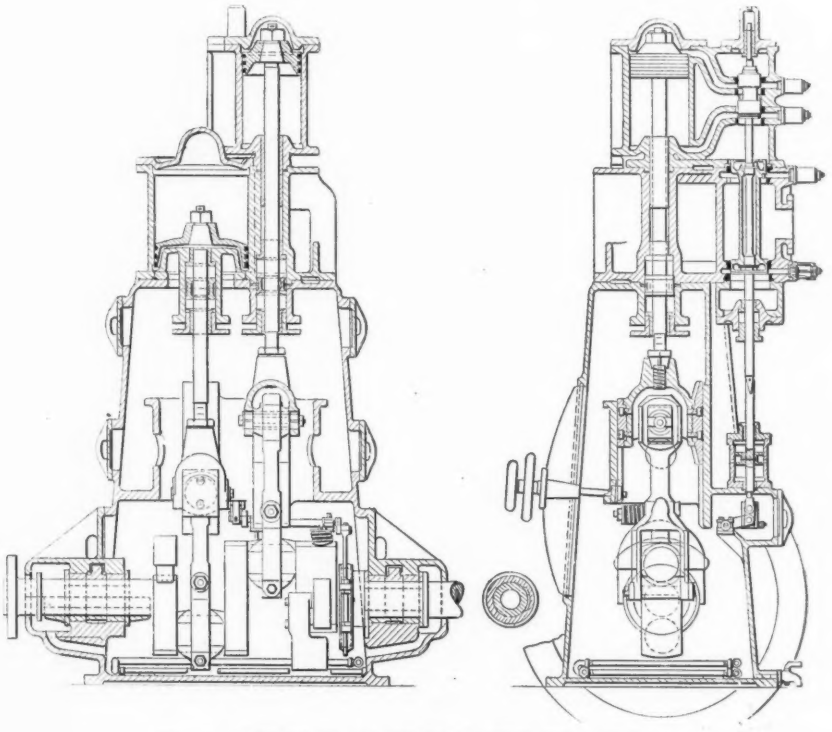


FIG. 1. SECTION OF AN ENGLISH HIGH-SPEED ENGINE

The Main Bearings

The main bearings are of phosphor bronze. It will be noticed that care is taken to support the weight of the fly-wheel, without wasting costly metal, by making the lower bearing adequate in length to its needs and without making the upper half to correspond in unnecessary symmetry. It is usually a difficult matter to induce oil to travel onto the surface of a bearing under pressure, unless means are provided to cause it to do so. To this end, therefore, a wide and deep channel is cast in each side of each top and bottom bearing, which not only permits oil to flow the whole length of the journal, but relieves the latter of dangerous side-pressure in case of overheating, and gives it a chance to get through with no more damage than a slight excess of heat which can be taken care of without stopping the engine. Adequately cut oil-channels in the main brasses, combined with the sweep of the journal, distribute the lubricant to all parts of the bearing.

A small end elevation, Fig. 5, shows one of the bearings from the outside; a cross-section shows the relief at the sides of the brasses (Fig. 1). Attention is called to the two big holding-bolts of the bearing-cap. An enlarged view is given in Fig. 6. Mr. Sisson has used this type of bolt for many years in all places throughout engine construction where parts are subjected to heavy shocks; for such purposes as holding down the engine bed where foundations are inadequate, in crank-pin brasses, crosshead brasses, etc. I believe that the idea was adapted from armor-plate practice. The theory is that a bolt so made will, upon sudden shock in the way of tension,

stretch in the reduced portion instead of stripping the thread or snapping. Its application in armor-plate is as a means of holding the plate to the ship's side, so that upon the impact of a heavy shell the holding bolts will stretch slightly. With plain bolts it was found that, upon the terrific blow of a shell, the bolts would either snap, or the nuts would strip and fly across the ship like bullets.

A striking feature of the engine is the provision for automatically taking up

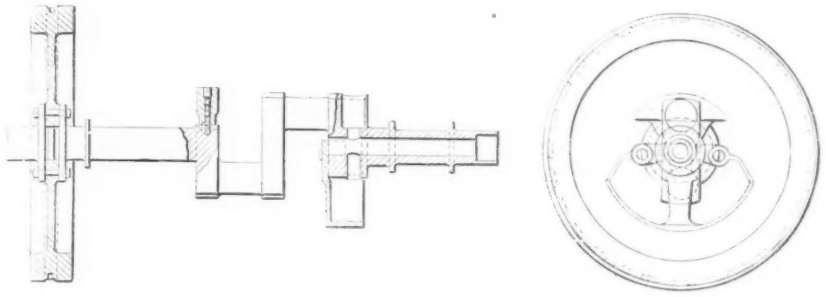


FIG. 2. CRANK-SHAFT DETAILS

wear while running. We will now see how this is accomplished.

The Connecting Rods

The main connecting rods are steel forgings of unusual shape. By reference to Fig. 3 see the peculiar features. It will be noted that the crank-pin brasses can accommodate themselves to the crank-pin in two directions, vertically and laterally. It will also be noticed that the brasses do not inclose the entire pin, but only cover an arc subtending an angle of about 120 degrees on top and bottom. The spaces at the sides are entirely cut away. This is done for two reasons: to save in weight of metal at a point where weight reduction leads to great gains in well-balanced running, and also to permit a liberal supply of oil to reach the crank-pin as the shaft churns the oil bath in the base of the engine.

Mention has been made of the long runs to which engines of this type are sometimes subjected; a slight reflection will show how important it is to avoid any strain in the nature of a twist or wind in bearings of such length, as it is almost impossible to avoid a very slight winding or eccentricity in comparing the motion at one end of the crank-pin with that of the other. Many factors come into play in the process of making a one-piece crank-shaft which are liable to cause this: an error of 0.004 or 0.005 inch in drilling the crank-pin centers, unequal annealing in the forging causing unequal wear on the centers in turning, a slight eccentricity of the live center in the lathe (a common error in large lathes); such discrepancies as these, which are almost impossible to avoid, are quite sufficient oftentimes to bring about an error of 0.003 to 0.004 inch in parallelism of crank-pin and crank-shaft axes. For these reasons the lower brass is mounted on a steel sleeve pinched tightly between the jaws of the connecting-rod fork. Freedom is permitted between fork and brass to the extent of about 0.004 inch. The surfaces of each are machined and then scraped by hand to a true fit. The brasses are of phosphor bronze, bored and scraped by hand. The upper half of the brass is fitted to the connecting-rod fork with the same degree of accuracy as the lower, and is provided on its upper surface with a machined portion scraped to a true sphere.

Against the latter presses a pad piece of swedish bessemer steel (a kind of steel made by a modification of the bessemer process, using swedish iron as a basis and producing a metal that lends itself admirably to case-hardening), shaped like an inverted mushroom. The upper and lower surfaces of the latter are case-hardened and polished highly. The wedge shown passing through the connecting-rod is of tool steel also hardened and polished and is held in place by a powerful coiled spring. The angle of this wedge is 1 to 4 and its upper surface bears against the hardened end of a swedish bessemer-steel plunger sliding in the bored-out trunk of the connecting-rod. This plunger bears against the lower gudgeon brass through the medium of a steel pad piece, and the upper brass bears directly against the upper end of the connecting-rod. This upper brass is made a tight fit in its place, but the lower one is free to slide. Great care is taken to insure the hardness and smoothness of the various hardened surfaces, as upon these qualities depends the successful working of this type of adjustment. The angle of the adjusting wedge was chosen as a compromise to permit of the various parts freeing themselves in case through heating the bearing pressure should become excessive. Attention is taken to insure that the supply of oil shall at all times be ample to all parts needing it. The crossheads are steel castings with slippers of hard, close-grained cast iron, turned to fit the bored guides.

By referring to the cross-section in Fig. 1, it will be seen that the slippers are attached to the crosshead by means of a portion turned to fit snugly into a bored recess. This makes a neat and mechanical job, amply strong to resist any shearing strain in case the guides should heat and seize. Thus the sole function of the two fillister-head screws is to hold the parts together; they have no shearing strain to resist.

Swedish bessemer steel is used for the gudgeon, which is hollow and split at the ends to permit two steel cones to be inserted and pulled inward to tighten the crosshead gudgeon. A key prevents it from turning in its bearings, which are bored a light driving fit. The sides of the gudgeon are flattened to prevent the formation of a rib as the brasses oscillate back and forth.

It will be noticed that the outer crosshead slipper is shorter than the inner one by about one-third. As the only period in which this slipper is bearing is at the ends of the stroke, with the piston cushioned, it is obvious that with practically no thrust the wear on this part must be light; hence, a characteristic reduction of weight in a fast-moving part.

The piston-rod stuffing boxes are provided with glands of ample length in addition to the bronze lantern bushings. The latter are free to slide with the packing and permit of an even distribution

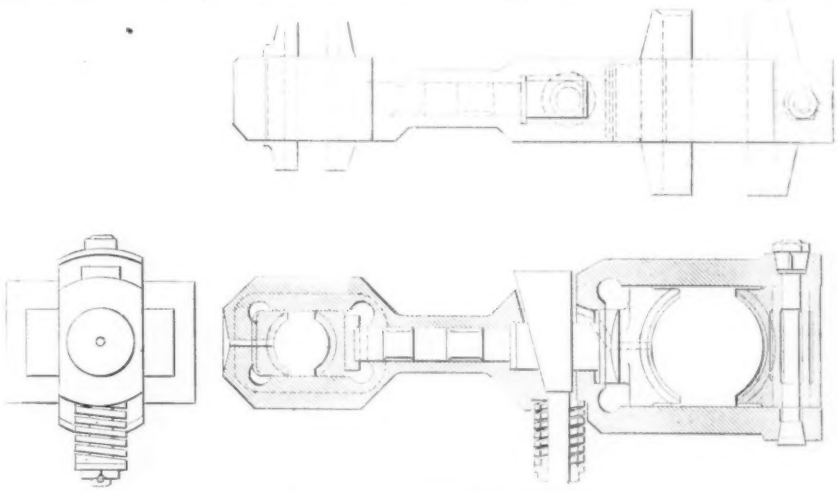


FIG. 3. CONNECTING-ROD DETAILS

in pressure. A drain pipe, which is not shown in the illustration, leads from these parts to the outside of the engine to take care of any condensed water that may collect.

The Pistons

The low-pressure piston is a cast-steel dish machined smooth on its upper and lower faces to reduce condensation, bored conical with a taper of 1 in 4 for the piston-rod and fitted to the cylinder with a clearance all round of about 0.004 inch. Three cast-iron rings made eccentric and cut in the thinnest part serve to keep the piston tight. The method of locking the piston into the crosshead has been evolved with much thought to avoid any tendency to work loose under the rapidly alternating tension and compression strains. The high-pressure piston is of solid cast iron. Through the front of the main casing is a large circular opening permitting of thorough access to the engine. A sheet-steel disk, turned up on the rim and having its edge machined, fits into this opening and is held against a circular machined surface in the manner shown in Fig. 1. Any oil from the return splash which may soak through this joint is retained by a circular groove recessed in a lip cast around the cover, flows to the bottom and finds its way back into the engine through holes drilled into the casing.

In addition to this large cover the engine is liberally provided with hand holes wherever needed.

In the base of the engine will be seen the pipes of the cold-water service which are called into play if the engine shows any tendency to heat.

While the shaft turns outwardly in running, throwing most of the lubricant against the guides and baffle plate, yet some splashes get past and, striking the low-pressure cylinder, are heated and fall into the rest of the oil. In later engines this has been carefully baffled against. In some of the earlier ones it has been found desirable to install the cooling system largely to guard against this feature.

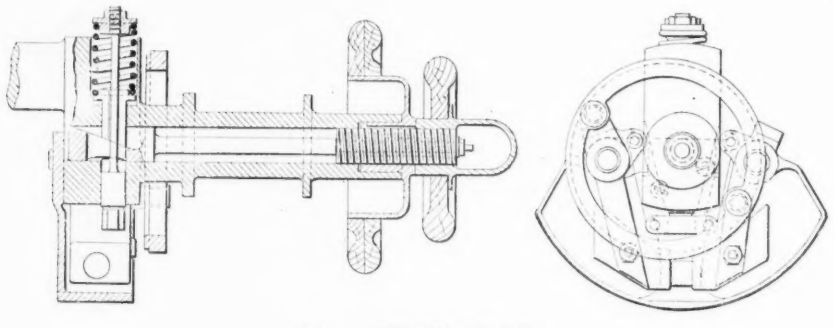


FIG. 4. GOVERNOR DETAILS

The Governor

The valve feature is unique. Reference to Fig. 4 will show that a single eccentric is held free from the shaft by means of two trunnion pins, which are mounted upon levers free to swing about axes that are fixed in their relationship to the crank-shaft, and are mounted in a casting fastened to it. These levers, which are steel forgings, have the governor weights fastened to their outer ends and are controlled through two links and a single tension rod by one coil spring of great power set in the end crank-web which is made specially wide and bored out to receive it. The levers are so mounted that centrifugal movement of one weight shortens the lead of valve, while a similar movement of the other weight decreases the throw of the eccentric; the two actions take place simultaneously.

It will be seen that the thrust of the governor spring is taken by a steel collar which in turn rests upon a steel wedge in the interior of the bored-out crank-shaft. The latter has a round stem which passes through the interior of the shaft and at its outer end is fitted with a sleeve, so attached that while quite free to revolve on the stem it cannot move in either direction without taking the stem with it. This sleeve has a square thread turned on it and a sliding keyway. Upon the sleeve are mounted two hand-wheels; the inner one feathered and free to slide on the top of the threads, the outer one with a thread cut to fit that on the sleeve. When in place, with governor gear set up, the feathered hand-wheel takes its thrust against the end of the shaft and the other wheel thrusts against its fellow; the pressure of the spring on face of wedge holds them to their work. When the engine is running the action of the governor can be modified by grasping the inner of these two wheels with one hand and turning the other to right or left, thereby putting greater or less compression on the spring. One object of this device is to maintain a constant output of electric current under all conditions, as there is a tendency on the part of the dynamo to change in efficiency as it heats up. Thus suppose an engine is driving a dynamo at 500 revolutions per minute. At the start of the run there would be a normal output of energy, but in the course of an hour's time heating of the coils would take place with a resulting loss in efficiency to the extent of perhaps 3 per cent.; thus an increase in the speed of engine of 15 revolutions per minute would bring things back to normal.

This hand regulation serves another useful purpose. In stations where the current is used for lighting a city the "peak of the load" occurs in the late afternoon and is especially heavy during the winter months. It usually reaches its highest point about 5 o'clock, at the time when store and shop and street lights are all going together, and just before the offices of professional men close. Thus for a period of perhaps 15 or 20 minutes the engineer in charge is often at his wits' end, should he be short of power. The hand adjustment of the Sisson engine is a friend in need at such times; a turn of the wheel gives the 5 per cent. or 10 per cent. extra power that is needed.

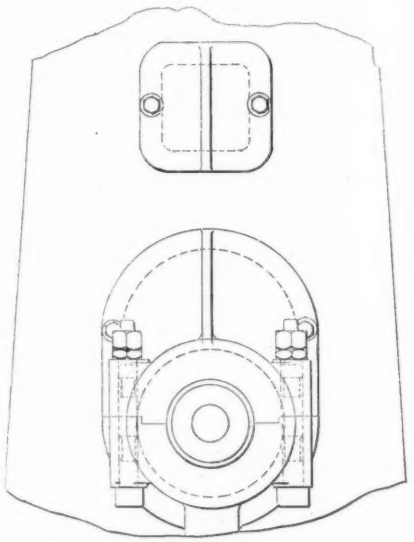


FIG. 5. DETAILS OF BEARING CAP

The eccentric strap and rod are in a two-piece casting of phosphor bronze as shown in Fig. 7. There again we see the characteristic opening at the sides. The eccentric connects with the valve spindle through the medium of rockshaft and levers. It will be noted that the eccentric is inclined away from the center line of engine at the top. This allows of modifications in setting the valves, by moving the pillow-blocks of the rockshaft back or forth as desired, before finally bolting them to the brackets.

The link connecting the rockshaft with the valve spindle is fitted with sliding blocks of phosphor bronze and a hardened steel wedge with a spring, to be self-adjusting as in the case of the connecting-rod brasses. On the lower end of the valve-spindle is a cushioning cylinder and piston, taking air through holes drilled in its sides. The object of this device is to absorb the shock as the valve parts are brought to rest at the end of each rapid stroke.

The Valves

The valves are both of the piston type.

made of hard, close-grained cast iron and are a floating fit upon the valve-spindle. The low-pressure valve in the smaller sizes of engine is like the high-pressure, fitted without rings, but is made a good sliding fit in its liner. These liners are of nickel cast iron, which gives admirable results; owing to its greasy nature it resists corrosion remarkably well, and in process of running takes a very smooth surface without perceptible wear. In fact, with proper care as to cylinder and valve lubrication, one of these valves will still show the tool marks after running for years, bearing striking testimony to the alinement of parts and also showing that the valve is truly balanced.

The valve liners are made a driving fit to their seats and are drawn into place by a nut and bolt. They are first well coated outside with red lead and oil. The high-pressure liner is made in one piece, the port edges are filed to correct dimensions before they are placed in the cylinder casting. The low-pressure liner is in two pieces.

The diameter of these valves usually bears a ratio to the diameter of the cylinder for which they are intended of about 1 to 0.38. The width of the steam ports measured vertically is about 0.14 of the diameter of the high-pressure cylinder.

Gun-metal relief valves are shown covering the "sighting" holes; these valves are absolutely necessary in piston-valve engines to take care of any water which may find its way into the ports. The high-pressure valve has inside steam admission; in order to avoid crossing of the ports, or a double eccentric system, the low-pressure valve has outside admission.

This arrangement works out well in another way, as it causes the low-pressure ports to be short and straight, thus avoiding some waste through the larger clearances of long ports. The small guide chamber at the top end of the valve-spindle is tapped for a grease cup to lubricate that part.

At the end of a long run the lubricating fluid is drawn off through the cock shown at the rear of engine; when ready to start again water is run into the lower part of the crank case until the bottoms of the crank-webs are just submerged when in their vertical position. On top of this water a layer of machine oil is poured to a depth of 3 to 4 inches. Under the tremendous churning effect of the cranks this soon forms a sort of emulsion which quickly finds its way to every part of the engine that it can possibly reach.

It may be of interest to give some consideration to the theoretical side of the Sisson engine design.

The Main Shaft

We will turn our attention to the shaft feature. An endeavor is made to balance the reciprocating weights in the two cylinders. This can be easily accomplished by utilizing the extra length of the high-pressure piston-rod to fill in the difference between the weights of the two pistons. Then each of the two outer crank-webs is counterbalanced, as shown by the governor gear at the high-pressure end and by a cast-iron balance weight at the low-pressure end.

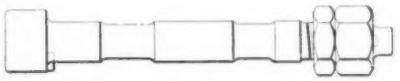


FIG. 6. DETAILS OF BEARING CAP BOLT

It is true that the various weights on the shaft are balanced correctly in the direction of revolution, but we have a slight rocking movement in the plane of the center line of the engine, due to the space between the piston-rod centers. As this space in most Sisson engines bears a relation, when compared to the distance between centers of the main bearings, of about 1 to 4½, it is obvious that the opposed rocking forces must be divided by 4½ to find their ultimate effect upon the engine as a whole, as applied to it through the main bearings. In a single-cylinder engine this reciprocating movement is entirely unbalanced, thus it will be seen readily that taking two engines of the same dimensions, the Sisson type will have an advantage of 4½ to 1 in lessened vibration

In the case of a side-by-side compound with cranks at 90 degrees, the advantage would be about the same in favor of the Sisson engine. What this means in reducing size of foundations, in lessening wear and tear on bearings, in freedom on the part of the construction engineer to place the engine in any part of any building where the floor will carry the weight, irrespective of whether the building is filled with offices or not, can scarcely be overestimated. I have seen a test, not

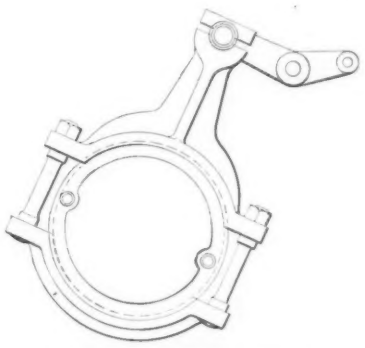


FIG. 7. ECCENTRIC STRAP

upon a heavy concrete bed, but upon a lightly bolted down cast-iron plate. The engine was a 6x10x6-inch running at 550 revolutions per minute. So quietly and smoothly did it run that an English half-penny, a copper coin 1 inch in diameter, was balanced, without a tremor, on the low-pressure cylinder cover.

At the Bankside electric light and power station, in London, an engine of this type, 15x24x15-inch, was selected to drive the large fan furnishing induced draft to 35 Babcock & Wilcox boilers with an output of 40,000 horsepower. The conditions were unusual; the fan was so mounted that any direct-connected engine would have to be set upon steel beams resting in the wall of the building. Only one engine was on the market whose designer and builder had faith enough in his product to stand by and see an engine of 500 horsepower so mounted, without fear of its shaking the building down. The Bankside engine has been running happily for 10 years past. Not only has it maintained its record for silent running, but also for steadiness, a matter of equal importance, as a shut-down means the putting out of commission of a large part of the 40,000 horsepower in the station.

A point which engines of the high-speed type have in common with the steam turbine is regularity in running. Comparing a Sisson engine of, say, 60 horsepower indicated, running at 550 revolutions per minute, with a cross-compound engine of the same power, but at 150 revolutions per minute, an irregularity to the extent of 3 per cent. on the part of the high-speed engine means 16½ revolutions per minute one way or the other; similarly in the slow-speed engine 3 per cent. means 4½ revolutions per minute. As in each engine there are four steam impulses to a revolution, it follows that while the slower engine is endeavoring to correct the fault with a margin of 18 impulses, the other engine has a margin of 66 impulses, or a ratio of 11 to 3 in its favor. In other words, it should correct a fault of this kind with one-fourth the error of the slower engine.

The majority of my readers will no doubt be interested in a consideration of the mathematical phase of the design of these engines. It was manifest from the start that the ordinary formulas for crank-shaft design would not serve. So standard practice was cast to the winds and instead of placing the main bearings as close to the line of thrust as possible it was desirable to separate them widely. This made it necessary to design a crank-shaft of unusual rigidity (this was also necessitated by another reason given later on) and this fact permitted bearings of exceptional size. The large proportion of journals and crank-pins combined with the quality of the gun steel used in its make-up, cause me to think that, for the size of engine, it is one of the strongest crank-shafts made. It is manifest that the main bearings should be so proportioned that a film of the oil and water mixture could always be maintained between brass and steel. It has given thorough satisfaction to allow these bearings such a projected area so that the maximum load is about 150 pounds per square inch,

with a journal speed of 360 feet per minute. This is with the non-useful portion of the bearing cut away, so that the area of contact top and bottom should subtend an angle of about 120 degrees, as shown in the small section. In order not to exceed this pressure the lower brass of the flywheel-end bearing is extended in each direction, making its length about three times the diameter of the shaft. The upper half of this bearing has little to do, as the lift of the low-pressure piston is off-set by the weight of the flywheel

Coming now to the crank-pin brasses we find a new element to contend with, for not only are the loads much greater, but there is also a constant pressure on each brass due to the self-adjusting mechanism. Let us consider for a moment what this amounts to independently of the load due to steam. In the 9x15x8-inch type of engine the size of the crank-pin is 4¾x7½ inches on its bearing surface, giving a projected bearing surface on the brass of 30 square inches. Now the wedge used to keep the brass against the crank-pin, as already pointed out, has a taper of 1 in 4. The spring controlling the wedge in this case exerts a pull of about 4000 pounds, creating a load on the brass of about 8000 pounds, allowing an efficiency for the wedge of 50 per cent. This load gives a pressure on the brasses of about 275 pounds per square inch. Such an engine as this works at a boiler pressure of about 120 pounds, so that when the thrust of the steam is added to that of the wedge the load reaches 600 pounds per square inch. Hence an additional reason for large crank-pins.

The maximum load on the gudgeon reaches a total of close to 18,000 pounds. Although this pressure, which is equivalent in the case of the 9x15x8-inch engine to about 1800 pounds per square inch, is incurred during the up stroke only; on the down stroke we have a pressure that is about half of this. These engines will carry their load with surprising regularity; a variation of more than 1 per cent. in speed is quite exceptional, even in cases where the load is whipping back and forth within wide limits.

At the request and solicitation of a number of gas- and gasolene-engine manufacturers and dealers, a call has been issued for a preliminary meeting to be held at Chicago, Ill., at the Auditorium hotel, Wednesday, December 9, 1908, at 10 a.m., to discuss and formulate plans for an association of gas- and gasolene-engine manufacturers and dealers, combined with manufacturers of the accessories to gas and gasolene engines.

George A. Orrok, mechanical engineer of the New York Edison Company, lectured on "Central Station Design" at the meeting of the Modern Science Club, Brooklyn, Tuesday evening, October 27.

Effect of Oil in Steam Boilers

By J. E. Terman

There are always engineers who, although apparently having had considerable experience, positively state that no bad effects can be produced directly from the introduction of oil in boilers. While no doubt regarding the danger or damage that may result from a deposit of oil on the interior portions of heating surface which is exposed externally to high furnace temperature exists in the minds of those who have been "through the mill," still it is not difficult to understand how the uninitiated are hard to convince of this fact. Of all the troubles that boilers are heir to, those caused by oil are probably the most erratic in nature, but after considerable experience with this form of trouble the similarity of the effects produced is so marked that it is comparatively easy to definitely diagnose the cause of trouble after the damage has been done.

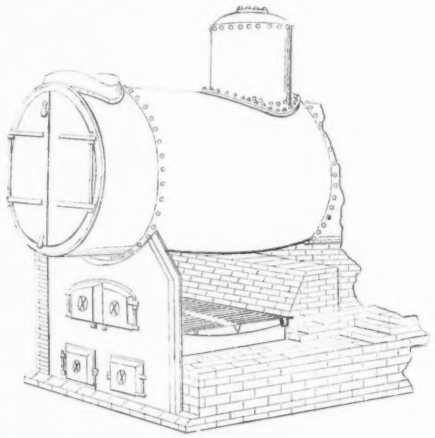


FIG. 1. TYPICAL OIL BAG

Bags Caused by Oil Have Characteristic Form

Bags caused by oil are a common defect in the horizontal tubular boiler, and they so rarely vary in form that it is only necessary for the practiced eye to view the exterior surface of the bag to determine the cause of the trouble. The invariable form of such bags is a relatively small depression in the sheets when compared with the area affected, while bags caused by scale or deposits in a boiler come down more sharply. Figs. 1 and 2 represent a bag caused by a coating of oil on the interior surface of the shell, while Fig. 3 is the characteristic form of bag caused by scale or mud. Another kind of trouble produced by oil in the horizontal tubular type of boiler is leaking at the girth seams; this generally accompanies the bagging of the sheets, but it sometimes occurs without perceptible distortion of the shell.

It is often hard to convince a boiler attendant that such a defect as shown in Figs. 1 and 2 is caused by a coating of oil on the shell, for in the first place it seems impossible that a coating of oil could so thoroughly prevent the transmission of heat as to cause the trouble, and in the second place the average man wants to see and feel the "stuff" that caused the trouble. Herein lies the great difficulty in making a convincing explanation, for when the sheet reaches a temperature sufficiently high to cause it to bag, it requires only a limited time at this temperature to carbonize the coating of oil and allow the water to come in contact with the sheet and cool it. The residue left floats off in the water to some other part of the boiler, generally leaving the bagged sheet cleaner than any other portion of the heating surface, and although the evidences of oil are numerous in other parts of the boiler, particularly near the water line, it is next to impossible to convince the man without experience that this is the cause of the trouble.

Clean Surface Required for Attachment of Oil

Another and equally difficult circumstance that is hard to account for is that one of two boilers which are placed side by side and operate under conditions as nearly identical as is practically possible may actually contain much greater quantities of oil than its mate and yet be unaffected, while the other is seriously bagged and burned. The only explanation for such apparent erratic action is the nature of the heating surfaces on which the oil may collect, for to cause overheating the oil must be in intimate contact with the plate, and a thin layer of scale may prevent the oil becoming closely attached to the sheets.

This feature of comparatively clean surface being required for the attachment of the oil is often a source of considerable annoyance to the boiler manufacturer, in this way: An addition is made to an existing plant and the conditions regarding the feed water have probably materially changed since the last installation of new boilers. The oil is now being returned to the boilers in comparatively large quantities, but on account of the old boilers having accumulated a considerable coating of scale before the conditions regarding oil had become serious, no injurious effects have been noted. The new boilers are installed and have been operating only a few weeks or months when the oil gets in its work and causes leaking at the girth seams and possibly bags the sheets. The manufacturer of the new boilers is notified at once of the trouble, and when his representative arrives and makes an examination and finds the seams overheated and the rivets loose and possibly the shell bagged, and the interior surfaces at the affected points clean, but quantities of oil in other portions of the boiler, or in some instances where the

overheating has been comparatively slight he can find a tenacious black coating of oil and dirt on or near the affected surfaces, he is at once satisfied that oil is the cause of the trouble, but convincing the owner and his engineer of this fact is quite another matter. That the old boilers are running under the same conditions as the new ones and have been doing so for a long time without giving any trouble, is a "clincher" to the owner's side of the argument that is almost impossible to overcome, and the trouble as far as he sees it is simply poor material or poor workmanship, or both.

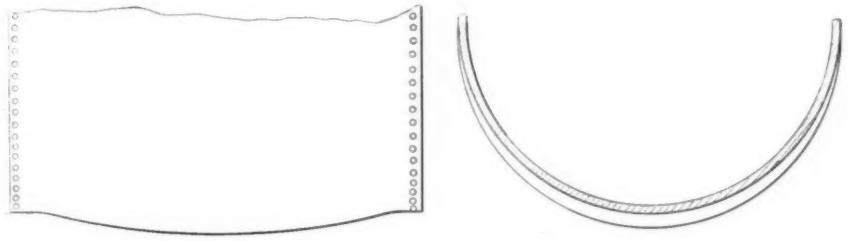


FIG. 2. SECTION OF SHELL SHOWING BAG CAUSED BY OIL

Oil Rarely Affects Return-tubular Boilers

The tubes of return-tubular boilers are rarely affected by oil. The ends, where expanded into the rear head, would be the place where the effects should be most apparent, but it is rare that oil deposits collect here, probably due to the circulation and also to the fact that scale becomes attached to the tubes and head very rapidly at this portion of the boiler, thus protecting the surfaces from the oil.

It generally requires that oil be fed into a boiler over a considerable period of time before any effect is noted. There are numerous engineers who make it a practice to put in directly on the fire sheets, after cleaning, large quantities of crude oil for the purpose of aiding in scale removal, and the writer has seen as much as four or five gallons put in at one time in this manner, but has never known a case where immediate trouble has arisen from such treatment. The probable explanation is that clean, fresh oil rarely becomes so closely attached to the sheets as to cause overheating, and it appears that it is necessary for it to be mixed with scale and loose dirt, forming a more or less spongy and sticky mass familiar to those who have had occasion to remove such deposits from boilers.

Oil in Vertical and Water-tube Boilers

The effect of oil in the vertical-tubular type of boiler is generally to cause leaking at the tube ends over the fire, although leaks at the riveted seams in the furnace or around the staybolts sometimes result from its presence. Oil in the vertical boiler is not as easily detected as in the horizontal type, as it tends to collect along the water line and there are generally no suitable openings for viewing the interior of the boiler at this hight. The leaking around the fire ends of the tubes is generally caused by a deposit of oil on the tube sheet and tube ends affected, but it can also be caused by deposits higher up on the tubes, which cause them to overheat and expand in length, and as this expansion is not uniform in all the tubes, some of them shift in the tube sheets in trying to accommodate the varying lengths.

When the leaking is caused by a deposit around the tube ends, it frequently happens that oil is drawn in between the tube and the surface of the sheet against which it is expanded, and in such cases the leaking can only be stopped by complete removal of the oil on the interior surfaces and re-expansion of the tubes as leaks develop until all of the oil between the tube and the sheet has been burned out. Oil in the water-tube type of boiler generally causes overheating and distortion of the tubes, and this in the more rigid types produces leaking at the tube ends. The shell plates and seams, where oil is liable to collect, are in most types of water-tube boilers so far removed from the furnace that it is rare that any effect is noted.

Use Soda Ash to Remove Oil

When the presence of oil is detected in any type of boiler, it should be removed as promptly as possible and its further entrance prevented. Its removal may generally be accomplished by a thorough boiling out with a large quantity of soda ash, which saponifies the oil and makes it easy to remove by washing. It is, however, sometimes necessary to repeat the treatment several times to completely remove all the oil, and in some cases it is necessary to use kerosene with the soda to accomplish the desired result.

Deposits Closely Resembling Oil

There are deposits which occur in boilers that closely resemble oil and frequently deceive those who have not had previous experience with them; one of these is vegetable matter which occurs where pond or swamp water is used for feeding. This causes deposits on the tubes, braces and shell along the water line which closely resemble oil deposits when damp, and it is extremely hard to dry out in the air. The difference may be detected at once by placing a small portion on a sliver and applying the light of a match; if oil is present it will blaze or splutter. Another deposit closely resembling oil is caused by the introduction of sugar. This frequently occurs in sugar-house work where sweet water is allowed to drain into the pond from which the boiler supply is drawn. This deposit is not as deceptive as the vegetable matter, for it dries more rapidly, and after a boiler containing it has stood open for some time, it peels up in flakes. The only detrimental effect caused by sugar is its tendency to cause foaming, for otherwise its presence is beneficial, as it apparently prevents other deposits from becoming attached to the boiler.

In the manufacture of boilers a certain amount of oil and grease mixed with rust and dirt is left on the interior surfaces, and unless this is removed by thoroughly boiling out with soda ash before the boiler is placed in service, it is very liable to cause serious foaming; and as all kinds of trouble are more or less expected when starting a new installation, it rarely happens that the correct cause is suspected, and generally the design of the boiler, or location and size of the steam outlet or the size and position of the steam header is blamed for the water coming over, when the chances are by long odds that thoroughly removing the oil from the boiler will prevent all trouble.

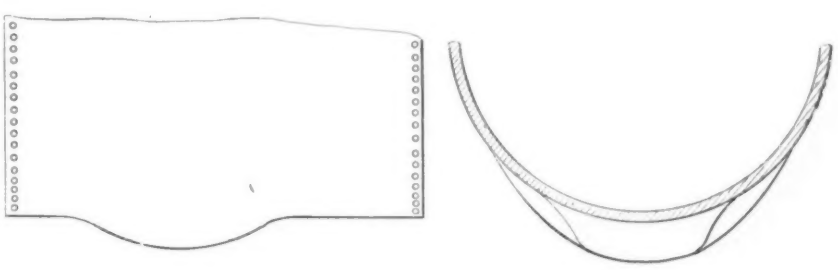


FIG. 3. BAG CAUSED BY LOOSE SCALE ON DEPOSIT

The Gas Power Section of the A. S. M. E.

Discussion of the Best Way to Promote Gas Engineering; More Extensive Investigation Recommended; Successful Bituminous Gas Producers

The season of professional meetings of the American Society of Mechanical Engineers was opened Tuesday night, October 13, by a meeting of the Gas Power Section of that society in the Engineering Societies building, New York. H. L. Doherty, chairman of the meetings committee, presented a communication which aroused animated discussion.

MR. DOHERTY'S SUGGESTIONS

Conduct of Meetings

We believe that the work of this section can be undertaken and carried out with more exact plans than have heretofore characterized association or society work.

We believe that the progress of the work of this section will be largely determined by the wisdom displayed in planning its work. None of our members would attempt to do any construction work without first making complete plans for the execution of this work. While the method used in the execution of construction work may not be a true example of how the work of this section should be undertaken, yet it is applicable to a considerable degree; and while we cannot now complete plans and specifications for the execution of this work, we wish to suggest a plan and submit it for criticism and suggestion.

We are organized primarily to assist the development of gas power, and to assist in the progress of the members of our fraternity. To accomplish our first object we must not only be able to influence all our own members, but must be able to influence all power users and their advisory engineers. To assist in the progress of our members we must not only furnish all possible information, but must maintain a sufficient interest in the subject to spur our members on to the greatest possible degree of achievements.

At best, we will probably have not more than fifty hours in session for the consideration of these subjects during the first year. It is, therefore, important that we should use the time at our disposal to the greatest possible advantage, conducting the sessions so as to bring out the most important matters as rapidly as possible.

The knowledge of gas power possessed by the different members probably ranges from that of the novice to that of the well-versed scientist. It is impractical to give time to the most elementary considerations, and we cannot assume that a large proportion of members have anything like complete knowledge of current practice, but it seems wise to assume for all a degree of knowledge readily obtainable from other sources and to frame our program so as to give a broad understanding of the subject, covering all fundamental information as fully as possible.

Value of Accurate Information

Should we fail to recognize the decided prejudice of many engineers and power users against gas power we would be unable to take proper steps for the removal of one of the greatest obstacles now retarding the adoption of gas for power purposes. It would be idle to maintain that no failures have been made in this field, but even repeated failures do not prove the actual limitations, while a single success does prove the possibility of again securing at least an equal degree of success.

More discussion relatively has been given to the failure of some gas-power installations than to the successes of others. This is not unnatural. The failure of the Quebec bridge brought many more columns of publicity than all the successful bridges erected in the past ten years, yet this failure no more proved that bridges cannot be used than gas-power failures prove that gas power cannot be used.

Probably no better contribution could be made to the more rapid development of gas power than to give the power-using public a complete list of plants already in operation. We, therefore, desire to collect such a list, with a description of each plant and a record of its performance. We want particularly to collect logs of tests and evidences of reliability as indicated by long and continuous runs, records of troubles and failures, and, as far as possible, an explanation for the causes for any trouble or failure which has been experienced.

It is doubtful whether the literature on this subject reflects the state of the art. There is always something, which never seems to be explained, which occasions temporary failure in all new undertakings, and can only be characterized as lack of craftsmanship. In gas-power work different principles are involved in the type of engine used; for instance, the different cycles in the engines, different principles in carbureters and producers, and indeed in every portion of equipment and almost every detail in each portion of this equipment.

The results secured by some plants in operation, compared with those of other plants of the same character, indicate a refinement in craftsmanship which, if properly analyzed and described, would be of much assistance in securing better results elsewhere.

We recommend a comparative analysis of the sources of loss in steam- and gas-power plants, showing points capable of direct comparison and the degree of each loss in each type; this analysis to cover the fundamental differences between the two, calling particular attention to the following points, which we cite simply by way of example, and which, owing to a lack of understanding of the subject, have frequently been responsible for the failure to secure the high economy expected from the use of gas power.

(a) A gas engine has highest efficiency at maximum load, a steam engine at some intermediate load, both being rated practically at their point of highest efficiency. Since the steam engine has a nominal rating greatly below its maximum capacity, it has a greater reserve capacity and much less nominal capacity is required than for gas engines; moreover, on a varying load the steam engine, by its ability to carry both overloads and underloads, can be kept operating more nearly at its point of highest efficiency than the gas engine, which must always be operated at or below its most economical load, thus practically permitting variations only on the side of underload, from an economical standpoint. This feature of the gas engine not only adds materially to the investment charges, as compared with the steam engine on the nominal rating of each, but also adds materially to the operating cost of the gas engine in relation to the greatest degree of economy attainable.

(b) The greater economy of operation will not offset the increased investment charges on large-size gas-power plants operating both on cheap fuel and a poor load factor, and as these charges are fixed in character, and greater for gas-power than for steam-power plants, the number of horsepower-hours generated per year in relation to each horsepower of capacity will determine whether the lower operating costs will more than make up the increased investment charges so that the commercial efficiency will be greater for the gas-power plant. In continuous operation each horsepower in capacity would be able to turn out 8760 horsepower-hours per year with a 100 per cent. load factor and only 876 horsepower-hours with a 10 per cent. average load factor. The cost of fuel will determine the load factor necessary to yield a higher com-

mercial economy for the gas engine, and the lower the cost of this fuel the less will be the operating economy per horsepower-hour generated, and, therefore, the gas-power plant is of less comparative value as the load factor and the price of fuel are diminshed.

(c) As the gas engine has a much lower efficiency at points other than maximum load in relation to the consumption at maximum load, it is essential that the units selected permit of being run at a higher individual load factor, when running, than would be required for steam units; and this disadvantage evidently renders the gas engine relatively less suitable for classes of work where this high individual load factor on each operating unit cannot be secured.

The above points, though simple and almost obvious, have been the source of considerable disappointment in the past, and it is not sufficient simply that our members understand such matters; we must make them known to power users, that they may not fall into error reflecting prejudicially on the adoption of gas power by others.

We recommend setting out fairly the points of merit and demerit of gas- and steam-power plants, making prominent the many advantages of the former, such as quickness and ease of starting, small standby operating charges, safety and availability, and ability to generate gas at one point and transmit it to a distant point for consumption—which is practically impossible with steam.

Neglected Opportunities

We also recommend steps to emphasize to our members and the power-using public the many ways in which gas engines can be used to secure the maximum of economy; such as the use of gas engines to carry that portion of a power load which is constant, running the engines at their maximum output, and using the old steam plant to take the load above this "base load;" using the exhaust of the gas engines for the generation of steam or the heating of feed water for the steam plant.

Much work is being done that is of an unpromising character, for example, the so-called gas turbine, as distinguished from a turbine using both gas and steam. To construct a straight gas turbine successfully on ordinary lines requires the transformation of heat energy to work energy at a temperature and blade velocity beyond the ability of any material now known to withstand. In spite of this fact, however, hundreds of hours and thousands of dollars have been wasted in the attempt.

On the other hand, many interesting fields are available which have not been fully called to our attention, such for instance, as gas-making methods with the recovery of by-products. Two instances might be used as examples to excite interest in this subject:

(*a*) Mond, by the use of a great excess of steam, keeps the temperature in the producer at a point which protects the ammonia from disassociation and secures a yield of practically twenty pounds of ammonia gas per ton of coal used. Ammonia in the form of crude concentrate brings a price of from five to ten cents per pound of NH_3; therefore, a credit can be secured of one to two dollars per ton of coal gasified. other than for the lower thermal efficiency in this method of operation and the expense necessary to recover and concentrate the ammonia.

(*b*) Thousands of tons of coal are coked annually in beehive coke ovens which waste all of the volatile products of the coal, including tar, ammonia and gas, excepting that which is usefully burned to carry on the coking process.

In spite of prejudice to the contrary, good metallurgical coke can be made in by-product coke ovens with the recovery of the same amount of gas, tar and ammonia that would be secured in the ordinary gas-works practice. It is customary, however, to use a portion of this gas to heat the ovens, although producer gas could be used if desired; but even when using a portion of the gas yielded by the distillation of the coal, about 50 per cent. of the better quality of the coal gas remains for use in other ways. This gas, by reason of its high hydrogen content, and also the presence of illuminating hydrocarbons, is not the most desirable for gas-engines use. By scrubbing with tar oils, the illuminating hydrocarbon vapors, which have too high a value for use simply as a fuel, may be recovered and the remaining gas can be used in engines to generate electricity, which can be transmitted long distances at minimum cost. This gas, when denuded of its illuminating vapors, has perhaps 90 per cent. of the value of the best gas which can be made for gas-engine use.

These two examples do not by any means cover this field; they are mentioned for the purpose of showing the importance of this branch of the work and also to excite further suggestions and exploitation on the part of members.

Marine and Railway Service

Probably no branch of the field has made more progress in the imagination of the engineering fraternity than that of marine propulsion. Naval officers of almost every country are interested in this subject and some interesting demonstrations have been made. We recommend an early statement of the development in this line, clearly setting forth its advantages and its special points of interest.

The problem of train propulsion by means of the internal-combustion engine and solid fuel has not excited the same interest as ship propulsion. In fact, gas power adapts itself much more readily to ship propulsion, the power required bearing some exact relationship to the speed of the vessel in relation to the medium through which it passes, while the grades of railroads, in conjunction with the weight of the load, present complications requiring maximum capacities and introducing poor load factors which do not exist in marine propulsion. Nevertheless, train propulsion is worthy of serious consideration.

Comparison of Internal-combustion Engines of Different Sizes and Types

We recommend special attention to the characteristics of internal-combustion engines of different sizes and types, such as automobile engines and standard engines used on different characters of gases and different classes of work. From such a comparison we believe that progress in certain types, sizes and characters would contribute to progress in other branches.

It is interesting to note that the bids and specifications submitted by the manufacturers of large standard gas engines showed an average weight of about 700 pounds per horsepower, while the average weight of all the automobile engines which took part in the Vanderbilt cup race was about 6¼ pounds per horsepower. One of the engines intended for use in this race had developed 220 horsepower on a time run. Such a difference in weight without a wide difference in capacity would indicate that large-sized standard engines could be built amply strong with less weight, less cost, and higher operating economy. Unnecessary weight, in this as in most instances, is a weakening factor and often a great obstacle to economy.

Measuring and Testing; Helpful Departments

Many errors have been due to faulty methods of measuring and testing. Some of our members are not even familiar with the standard apparatus now on the market for this purpose. A treatment of this subject, showing methods of measurement, including the Pitot tube, and Venturi meter, the old wet-gas station meter, the different forms of proportional meter, the rotary meter, and the twin gasometers, would probably accomplish much good.

Methods of analyzing gases to secure greater speed and accuracy would also prove of great benefit. As an example, the Tuttle improvement of the Orsat apparatus makes three determinations possible almost in the time formerly required for one. Many other little wrinkles can be introduced, contributing both to speed and accuracy. For instance, by the use of an extra pipette—having two pipettes of cuprous chloride—the partially exhausted reagent can be first used for the absorption of the carbon monoxide, keeping the cuprous chloride in the other pipette comparatively fresh and capable of greater absorption and quicker work.

Most of the gas associations have what

is termed a "Wrinkle Department," to which all members contribute any ideas which prove of benefit in their work. The term "wrinkles" is assigned to these as generally covering improved apparatus or methods of a simple but clever character which could hardly be dignified by the name of invention and are yet of much practical value. The National Electric Light Association has established a "Department of Progress," in charge of an editor whose duty it is to collect all possible reports of progress, summarize them, and present them to the members of the association from time to time. We believe that both such departments could be established by the Gas Power Section to advantage.

In the discussion of Mr. Doherty's communication several speakers referred to the fact that complete information regarding the failure of a gas-power plant is seldom obtainable, and all were emphatic in advocating the free exchange of such information for the general benefit of the industry. D. B. Rushmore said, also, "If this section is going to be as successful as it ought to be, it has got to be careful that the facts brought before it are reliable."

Mr. Bump suggested that the question of what constitutes a competent gas-producer or gas-engine operator should be determined by the section and the requirements put in plain language, so that the practical worker will be able to understand readily the standard up to which he must measure and to obtain the information necessary to meet the requirements. He suggested the question-box plan as a promising one for promulgating knowledge of this sort and for giving operators the benefit of each other's experience.

Prof. Sidney A. Reeve referred to the attractiveness of the outside-compression engine, and said that no one has yet succeeded in producing a successful engine of this type. This form of engine has as great flexibility as a steam engine, with respect to overloads, having the characteristic of all other power-plant machinery of reaching its maximum efficiency before the maximum load-carrying ability is reached.

Heat Value of Power Gas

Referring to the matter of standardization, which is now being given earnest consideration by the Gas Power Section, Charles W. Lummis, of Camden, N. J., in a written communication offered a most practical solution of the problem of dealing with the two heat values of gases used in engines. He favored stating the total heat value of the gas and also indicating its value to the gas engine by specifying the ratio of higher, or total, heat to the lower heat value, terming this ratio the "power factor" of the gas. Thus, if the higher value were 140 B.t.u. per cubic foot and the lower value were 132, the power factor would be $132 \div 140 = 0.943$, or 94.3 per cent. The total, not the available, heat in the steam supplied to a steam engine is the quantity considered; so, also, as to the steam delivered by a boiler. And, since it is only fair to credit the producer with all the heat in the gas which it delivers, it is only consistent to retain this value when the engine is considered, indicating the proper allowance to be made for the latent heat, however, by stipulating the "power factor," as suggested.

Mr. Lummis further expressed the opinion that the Gas Power Section should investigate very closely the subject of correct producer-gas analysis; he also thought that, while the fuel consumption per unit area of grate or fuel bed is an important point, it is not fair to rate producers on this basis. With anthracite coal, the operation of a producer is just as largely dependent on the ability to get rid of the ash; he knew of cases where improved means of removing ashes gave one producer 50 per cent. more output than another of the same size not similarly equipped. With bituminous coal there also arises the question of the caking and coking qualities of the coal, the sulphur contents, etc., which influence the quantity that can be gasified per square foot of grate or fuel bed area.

Discussing Mr. Lummis' communication, Professor Reeve advocated the use of the total heat value of gases supplied to engines, for the reason that the case was similar to that of the steam engine except that the latter runs on latent heat entirely, whereas the gas engine runs partly on latent heat. J. R. Bibbins argued for the use of lower or effective heat value because the presence of hydrogen in the gas is the fault of the producer, not of the engine, and the engine should not be charged up with the unavailable latent heat entailed by the hydrogen in the gas.

BITUMINOUS PRODUCER PLANTS

A paper of the above title was read by Elbert A. Harvey. The author described three producer plants installed by the Industrial Gas Company, two for power purposes and one for heating, and gave some operating records. All three plants burn bituminous coal in updraft producers without any attempt to burn the heavy hydrocarbons or tars into gas in the gas generators, the hydrocarbons being removed from the gas by rotary mechanical cleaners, leaving in the light hydrocarbon constituents. The plant equipment includes also apparatus for the recovery and utilization of the tar removed from the gas, deriving from this the power for the operation of the gas washer and the necessary steam for generating the gas. The final product comprises a clean, cool producer gas, amounting to about 75 per cent.; tar, amounting to about 12½ per cent.; and sensible heat lost in radiation from the gas generators and carried away by the cooling water, amounting to about 12½ per cent.

The producer is of the updraft water-sealed type developed directly from the original Siemens producer, and today used in identically the same design (but not in connection with cleaning apparatus) with open-hearth and glass-melting furnaces, and for a great variety of processes requiring raw, uncleaned producer gas.

The rotary gas washer is the direct outgrowth of the rotary dust cleaner for blast-furnace gas which had its development in Germany; and the tar-burning outfit is simply a variation of fuel-oil equipment.

The plant first described is that of an Indiana glass-manufacturing establishment, which is operating on producer gas made from Indiana and Pittsburg bituminous coal and developing 1320 brake horsepower, as the average. The power equipment consists of four Taylor gas generators, 10 feet in diameter, remodelled in 1907 by the Industrial Gas Company so as to include the Herrick tuyeres; two Saaler rotary gat washers, with accompanying coolers and dry scrubbers, installed in 1906-1907; three 600-horsepower Koerting double-acting two-cycle gas engines, driving three 400-kilowatt Westinghouse alternators connected in parallel (two engines are in constant service with one spare idle unit); one 150-horsepower Westinghouse vertical three-cylinder gas engine, direct-connected to a direct-current generator for lighting purposes.

This power plant has been operating for more than a year and made a complete continuous run during the year of 1907, 24-hour service most of the time, furnishing power in a satisfactory way to meet the local factory conditions. Complete statistics of this plant are not available. The engines are showing excellent economy, averaging 10,573 B.t.u. per brake horsepower-hour. However, they have not been satisfactory in all particulars, and this type of engine has since been withdrawn from the market by the De La Vergne Machine Company, whose present engines are showing considerably better fuel economy and better construction in other details. This company operates two power plants; one, the gas plant just referred to with its average load of 1320 horsepower and an average coal consumption of 15 tons Pittsburg No. 8 three-quarter lump per 24 hours; the other is a steam plant; average load, 1250 horsepower; average consumption of the same coal, 75 tons per 24 hours. The two plants present one of the most striking illustrations of the contrast between power plants of this size, both operating under the same factory conditions. The gas equipment cannot be considered the equal of what could be put in at the present time, but it is a pioneer plant which

has done yeoman service in demonstrating the possibility of successful continuous operation, both of the engine and the producer.

Detailed statistics are not furnished for this plant, but the record for the year 1907 showed a total coal consumption in the producers of 1.34 pounds per kilowatt-hour at the switchboard, equal to 0.9 pound coal per horsepower-hour on the driving wheels of the engines. These figures, however, do not include the fuel required to operate the rotary washer and make steam for the producers; this increases the figures to 1.75 pounds of coal per kilowatt-hour at the switchboard and 1.06 pounds of coal per horsepower-hour at the engine shaft. The fuel figures for the auxiliary equipment are estimated, and cannot therefore be presented as authentic.

The actual cost of power for this plant is not available, but the two principal factors are known, namely, the coal consumption and the number of men employed. The steam and power required for auxiliary equipment can be closely estimated, and other charges based on standard practice. The figures in the following table are made up on the basis of the cost of 1320 horsepower average load during 24 hours.

COST OF GAS POWER IN 1907 AT THE INDIANA GLASS MAKING PLANT: 1800 HORSE-POWER IN THREE UNITS, TWO OPERATING AND ONE IDLE. SERVICE TWENTY-FOUR HOURS PER DAY, SIX DAYS PER WEEK. COST FOR ONE DAY OF TWENTY-FOUR HOURS.

COAL.		
In producer, 15 tons per day at $2.50		$37.50
STEAM.		
35 horse-power for gas washer at 34½ pounds per horse-power	1210 lb. per hour	
For gas making.. 415 lb. per hour		
This makes approximately 46 horse-power, costing say 50c. per day		12.00
WATER.		
3 gallons per horse-power hour in cooler		
2 gallons per horse-power hour in rotary washer		
9 gallons per horse-power hour in gas engine jackets		
This figures 450,000 gallons per day, costing at a pumping charge of one cent per 1000		0.45
LABOR.		
One head gas man for each day and night shift, superintending the producer men and in actual charge of the gas washers, cooler and dry scrubber, at $2.50	$5.00	
Two producer men for each shift, charging coal, poking producers, and cleaning out ashes, at $1.50	6.00	
One gas engine engineer responsible for engine room both shifts, and in actual charge one shift	3.00	
One assistant gas engine engineer in charge of engine room, night shift	1.75	
Two engine room oilers and helpers each shift, $1.50 each	6.00	
One helper: the coal is brought to the charging platform, the ashes carted away, tar removed, and there is other intermittent work attended to at odd times by various laborers, making the full equivalent of one man's time each shift, at $1.50	3.00	$24.75
Oil and waste		3.00
Light and miscellaneous expenses		1.00
Total operating charge per day		$78.70
OVERHEAD COST.		
Assuming a total investment of $100 per horse-power for an 1800 horse-power gas power plant, amounting to $180,000, and figuring 15 per cent. overhead charge to cover interest, depreciation, maintenance, insurance, taxes and supervision there is a yearly fixed charge of $27,000, or per day		$90.00
Total cost of 1320 electrical horse-power at switchboard for one day, 24 hours		$168.70
Cost per kilowatt-hour at switchboard		0.008

The other power plant is at the works of the Garford Company, Elyria, Ohio, and was started in May, 1908. The equipment consists of a 750-horsepower producer plant, 500 horsepower in Alberger gas engines direct-connected to generators, and a number of gas furnaces. Their entire equipment is piped so that either natural or producer gas can be used, and experience has shown that one gas can be turned on and the other turned off simultaneously without any interruption or bad effect on operating conditions. This is true both of the engines and furnaces. The engines run at full rated capacity with 115 pounds compression on either producer gas or natural gas. It was expected it would be necessary to raise the compression in order to get full capacity from producer gas, but this did not prove to be the case, doubtless because the engines were somewhat over-rated.

Very complete costs of power and of gas for furnace purposes have been made up by the Garford Company, their engineering department having run a number of tests during which they took fifteen-minute readings of all data, including coal and water consumption, temperatures, pressures, switchboard readings, engine cards, gas analyses, etc. The final and official test was made during a continuous run of 125 hours, at a time when the plant was operating 24 hours per day. The plant usually runs 10 hours per day, 300 days per year, carrying an average power load of 175 kilowatts at the switchboard, and burning on the average in the furnaces 4000 feet of natural gas per hour, or its equivalent. The tabulated figures indicate the costs for a period of one year under their normal average conditions.

COST TO THE GARFORD COMPANY AT ELYRIA, OHIO, ON AN AVERAGE POWER LOAD OF 175 KILOWATTS PER HOUR, 3000 HOURS PER YEAR, AMOUNTING TO A TOTAL OF 525,000 KILOWATTS AT THE SWITCHBOARD, AND GAS USED IN FURNACES AVERAGING EQUIVALENT OF 4000 FEET NATURAL GAS PER HOUR DURING 3000 HOURS, OR A TOTAL OF 12,000,000 FEET PER YEAR.

COAL.			
		Pounds.	
Coal burned in producer for gas for engines at 2.18 pounds per kilowatt-hour at switchboard, 175 kilowatt load		383	
Coal burned in producer for furnaces requiring 85 pounds to produce the equivalent of 1000 feet at 4000 feet per hour		340	
Coal burned in producer for gas burned under boiler		75	
Coal burned under boiler		75	
Total coal per hour		873	
Total coal per day during working hours		8730	
Stand-by losses at night		500	
Total coal burned per day		9230	
Costs per year of 300 days, 1385 tons at $2.20			$3046.00
STEAM.			
Steam furnished by boiler and the coal used by boiler are divided as follows:			
		Pounds.	
Steam for washer and engine, 36½ horse-power		1260	
Steam for producer		326	
Steam for tar outfit		286	
		1872	
Supplied by 80 pounds tar		940	
Supplied by 75 pounds coal gasified		492	
Supplied by 75 pounds coal burned on grate		440	1872
LABOR.			
One head gas man, 25c. per hour, 4000 hours	$1000.00		
One helper, 15c. per hour, 4000 hours	600.00		
One extra man for ash, etc., 18c. per hour, 1500 hours	270.00	$1870.00	
One gas engine engineer at	$1500.00		
One assistant at 22½c. per hour, 3000 hours	675.00	$2175.00	$4045.00
WATER.			
City water from Lake Erie: engine water, 16 gallons per kilowatt-hour	8,400,000		
Washer water, 1000 gallons per hour	3,000,000		
Cooler, 1750 gallons per hour	5,250,000		
Boiler, 250 gallons per hour	750,000		
At $0.06 per gallon	17,400,000		$1044.00
MISCELLANEOUS SUPPLIES.			
Oil	$320.00		
Waste and packing	60.00		
Sparking plugs	50.00		$430.00
REPAIRS.			
Estimated by engineer			$520.00
OVERHEAD CHARGES.			
15 per cent. on total cost estimated for power and fuel gas equipment of $51,620.00			$7743.00
Total annual cost for power and gas			$16,828.00

SUMMARY.

Items.	Cost of 525,000 Kw. Per Year.	Cost of Equivalent 12,000,000 ft. Natural Gas Per Year.
Coal	$1635.00	$1411.00
Labor	2175.00	1870.00
Water	504.00	540.00
Miscellaneous expenses	330.00	100.00
Repairs	320.00	200.00
Overhead charges, 15 per cent. on investment of which 37½ per cent. is for gas plant and 62½ per cent. for engine plant	4843.00	2900.00
	$9807.00	$7201.00

Cost per kilowatt-hour, $0.0187.
Cost for the equivalent of 1000 feet natural gas, $0.585.

The plant ran successfully and for a long period on Ohio slack, but comparative tests determined it was cheaper to use Pittsburg run-of-mine, on which they are now operating, the coal averaging 13 500 B.t.u. per pound, costing $1.10 at the mine with $1 freight and 10 cents unloading charge, making the total cost of $2.20 per ton of 2000 pounds in the bins.

In conclusion it may be said that the successful making of clean gas suitable

for gas engines and small furnaces from bituminous coal and for continuous operation has been established beyond question. The cost of the equipment, however, and of its operation, is such that under usual conditions this type of equipment is not a good investment for power plants below 250 horsepower, the simple anthracite suction producer presenting a better proposition; and the advantage of this type of apparatus for furnace operation would depend in every locality on the price at which natural gas and fuel oil can be secured and the quantity in which gas is required.

Discussing Mr. Harvey's paper, John C. Parker pointed out that the comparison of the gas and steam equipment at the Indiana plant is misleading unless local conditions are understood; the average load factor of the gas plant was very near unity [the figures stated work out at 67.7 per cent.—Ed.] and if the steam plant was not working at as high a load factor the comparison is unfair to it. Furthermore, as the gas-producer fuel consumption does not include that for steam generation and driving the washers, it would seem fair to omit the steam-plant auxiliaries from consideration. The coal consumption of the steam plant seems abnormally large; the results obtained at the Geological Survey plant, at St. Louis, showed an average fuel ratio of 2.7 and a maximum ratio of 3.7 as between steam- and gas-power plants, on the basis of brake horsepower, while the Indiana plant figures charged the steam equipment with 5.27 times as much as the gas equipment consumed, per brake horsepower-hour. Mr. Parker also suggested the desirability of improving the efficiency of gas-power plant auxiliaries, pointing out that the usual type of washer engine is very inefficient and that some of the heat now wasted could be profitably applied to making steam.

Mr. Parker further suggested that Mr. Harvey's labor charges could not be taken as generally applicable. In and around New York, for example, $18 per week is an average rate for an attendant in a small plant, and the skilled men required for larger plants cost more. Referring to the general question of the class of labor required for handling gas-power equipment, Mr. Parker presented a forceful argument against the employment of inferior men. As to Mr. Harvey's figures for fixed charges, he thought at least 20 per cent. should be allowed, and possibly more, for the aggregate of interest, depreciation, maintenance, insurance and taxes; he also emphasized the fact that the load factor of a plant affects the fixed charges and labor cost, per unit of output, enormously.

"If the gas-producer plant is to meet the competition of the steam-turbine plant, which has the advantage of extremely low first cost and excellent efficiency over a wide load range," he said, "it is essential that costs should be reduced as speedily as possible to a competitive working basis."

Mr. Bibbins disagreed very emphatically with Mr. Harvey as to the merits of tar-carrying gas. The ideal system of gasifying bituminous coal, he said, should include means for the complete destruction of the tar in order to obviate the difficulties caused by an accumulation of tar. He said that a producer of which he had knowledge had been under fire continuously for six months without discharging any tar or making any clinker, and with an efficiency comparable to that obtainable in a producer making tar. Mr. Bibbins also pointed out that the use of gas engines at mining centers, to utilize poor qualities of coal, or culm, is not very attractive because the chief virtue of a gas engine is economy in fuel, and wheer fuel costs little or nothing, the steam turbine is usually favored.

A paper by N. T. Harrington on "The Loss of Fuel Weight in a Freshly Charged Producer" was presented by title, but not read, Mr. Harrington being absent and the hour late when the preceding discussion closed.

The Real Efficiency of Steam Boilers

By Harold V. Coes

In the September 1 issue, W. H. Booth, in his article on "The Real Efficiency of Steam Boilers," has brought out some pertinent facts regarding this subject. Steam boilers are not as efficient for power purposes as the figures obtained by some experts would ordinarily imply. In practice there are many losses which tend to reduce the boiler efficiency to less than two-thirds, and the total efficiency of the steam-generating apparatus to less than one-half.

As the ordinary phenomena of heat evolution and heat absorption and transmission go on in the furnace and the boiler, the principal losses are about as follows:

Part of the unburned and partially burned combustible matter drops through the grates; part of the volatile matter escapes unconsumed, or is partially burned; and part of the potential or total heat of combustion in the coal is radiated through the fire doors and boiler setting. The first of these three losses can be prevented by careful firing or by automatic stokers of good design. The second is, perhaps, the most serious and the most difficult to deal with. The first two losses diminish the actual total heat which is evolved in the furnace and also lower the temperature of combustion, thus reducing the ignition temperature of some of the hydrocarbons resulting in smoke, soot and incomplete combustion with the attendant lowered efficiency.

Furthermore, we have the heat lost in the waste gases, since no boiler reduces the temperature of the gases to the temperature of the steam.

Unless a balanced draft is used, cold air leaks through the fire doors and settings, diluting the gases and reducing the temperature, thereby increasing their weight with the consequent loss up the stack.

The hygroscopic moisture of the air for combustion and the contained moisture in the coal as well as the moisture formed by the union of the hydrogen and oxygen; with its high specific heat increases the loss up the stack.

For most of the commercial types of boiler the process of heat absorption takes place before and simultaneous with the process of heat evolution and before the latter is complete. This is particularly true for those boilers where the flame reaches the tubes or heating surfaces or where they are not provided with a tile roof. Necessarily such an abstraction of heat reduces the final temperature of the products of combustion and consequently lowers the efficiency since incomplete combustion takes place.

The generally accepted true boiler efficiency is stated thus:

$$\textit{Efficiency} = \eta = \frac{\textit{A. S. M. E. Code Efficiency (Item No. 72)}}{100 - [\%\ \text{CO}\ \textit{loss} + (\textit{unaccounted for item in}\ \% - 3\%)]}$$

which is rather crude on account of the quantity in parentheses; yet this is the best we know.

Let us compare this with John Perry's expression for boiler efficiency as deduced in his book on "Steam Engineers and Gas and Oil Engineers." He states that the rate of impartation of heat to a boiler tube or flue is proportional to: (1) The temperature difference between the gases and the heating surface: (2) The density of the gas: (3) The velocity of the gas parallel to the heating surface and direction of flow, and (4) the specific heat of the gases at constant pressure.

The first factor is our fundamental thermodynamic expression

$$\frac{T_1 - T_2}{T_1} =$$

efficiency, but this is only one of the factors, consequently

$$\frac{T_1 - T_2}{T_1}$$

of itself does not give a true expression of boiler efficiency.

Perry's statements expressed mathematically are reduced to

$$H = C\ p\ v\ (T_g - T_w),$$

where

H = Amount of heat transmitted,

C = Specific heat times a constant,

p = Density of the gas,
v = Velocity of the gas parallel to the heating surface,
$(T_g - T_w)$ = Temperature difference of the gas and water.

Perry then by the kinetic theory of gases and by the aid of the integral calculus arrives at the following expression for a boiler flue or tube:

$$Efficiency = 1 - e^{-\frac{Cl}{D}},$$

where
e = Base of naperian or hyperbolic logarithms,
D = Diameter of tube or flue,
l = Length of tube or flue,
C = A constant depending on the type of boiler.

This equation then states that the true efficiency of a boiler flue or tube depends only on its length and diameter and not on the initial temperature of the gases, as some would have us believe. That is, it is the ratio of the heat absorbed by the boiler flue or tube to the heat available for absorption, as may be seen from the deduction of the formula. What holds good for one tube or flue holds good for all.

Let
H = Potential heat of coal, or heat of combustion,
T = Heat evolved in furnace or available heat,
A = Heat absorbed by the tubes or flues,
E_1 = Efficiency of the furnace,
E = Efficiency of the boiler or tubes or flues,
η = Efficiency of the whole apparatus.

Then

$$\frac{T}{H} = E_1 = \text{efficiency of furnace,}$$

and

$$\frac{A}{T} = E = \text{efficiency of boiler} = 1 - e^{-\frac{Cl}{D}}.$$

Therefore the combined efficiency is

$$\frac{T}{H} \times \frac{A}{T} = \frac{A}{H} = \eta.$$

or the overall efficiency. These, then, are the efficiencies that Mr. Booth comments on in his paper. He has shown very ably the desirability of differentiating between boiler and furnace efficiency and the discrepancies that such differentiation does away with.

Filing Copper

To file copper easily and clean, without clogging the file, wipe the file frequently with waste that has been dipped in kerosene. Take care not to work until the file gets real dry. By this means a splendid finish can be obtained in a short time without clogging the file.

The Gas Producer

By F. C. Tryon

Comparatively a few years ago it seemed that the resources of the coal mines of the country then developed contained enough fuel to last for thousands of years; today we know much nearer the ultimate resources of the developed and undeveloped sources of supply, and at the rate its production and use have increased in the last few years, the entire supply will probably be consumed in hundreds instead of thousands of years. One of the most unnecessary of its wasteful uses is the development of power through the medium of steam, by which only about 6 to 10 per cent. of its heat energy is utilized. The remedy for this extravagant use of heat energy lies in the gas producer, which is so much more economical in its transformation of heat energy that its general adaptation to that purpose is only a matter of the time necessary for its possibilities to be understood by the layman.

The gas producer, in its construction, varies but little from the self-feeding parlor stove, and its operation differs chiefly in collecting the gas it makes and delivering it to another vessel for use. The parlor stove turns the solid fuel into a gaseous form and takes in sufficient air to make, with the gas, a combustible mixture which is burned then and there, completing in one unit the generation of sensible heat, while the gas producer performs only one of the functions of the stove; it turns the solid into a gaseous fuel, and delivers this fuel to be burned elsewhere.

The gas producer is applicable for any form of heat, as well as power, production. It can be used on the farm to drive a small gas engine for threshing grain, grinding and cutting feed, churning butter, pumping water, driving washing machines, also driving, during the evening hours, a small electric generator for providing light for the house and other buildings. While supplying gas to the engine to provide the power for these labor-saving necessities, it can also furnish gas for the cooking of food, heating of water for bathing, laundry and cooking purposes, warming the house—in fact, there is scarcely any work to be done around a farm or a large country place that the gas producer and engine cannot take care of, as to primary supply of heat and power. For the more pretentious country or suburban home, the gas engine could, of course, also drive a small refrigerating plant for supplying ice and cooling storage rooms or boxes where provisions are kept.

A city apartment house or hotel can be rendered independent of the gas- and electric-light companies by means of the producer and engine. Light, elevator service and gas for hot-water cooking and heating in all parts of the house can be supplied from such a plant. Hot air or gas grates can be supplied in winter, and cooled air for the hot-weather season is desired.

The gas producer and engine afford the ideal power supply for the small manufacturer or any establishment using a small amount of power, such as printing offices, machine shops, toolmakers, etc.

Not only are these applications possible as engineering propositions, but they are economical in comparison with any other methods thus far developed, no matter how small the requirements, within limits at all worth consideration—say from 25 horsepower up.

The gas producer and gas engine to the large manufacturer offers the minimum fuel expense, minimum labor expense for power production, and reliability equal to that of any other method of power production by burning fuel, up to something like 3000-horsepower engine units. Besides the advantages in power production, it has still greater advantages in the production of heat. Until quite recently it was supposed that the limit of heating ability by producer gas was quite low, about 1000 to 1200 degrees Fahrenheit being considered the extreme temperature obtainable by its use. It has, however, been found practicable to obtain temperatures up to 3500 and 4000 degrees Fahrenheit, and there is no indication that this is the limit; even this available temperature will extend the use of producer gas into many new channels, such as forging, annealing, melting of metals, welding of joints instead of riveting, smelting of ores, burning cement and lime, drying and burning bricks. For all of these and many other uses requiring high heats, coal has been used heretofore in a prodigiously wasteful manner which is no longer justifiable.

Two Good Suggestions

By James E. Noble

The writer was once employed where economy was considered before safety, so it occurred to him that it would be a good idea to keep a record of everything about the conduct of the plant which did not appear to be right, or safe. This record he called his "mechanical record," and it served as a sort of protection if anything went wrong. Thus, if any of the apparatus was deemed faulty, entry was made in the record, which was afterward submitted to the "boss," then if an accident occurred the engineer was less likely to be blamed.

Another thing which the writer found advisable while at that plant was to take out a life-insurance policy, and he heartily recommends both plans to his fellow engineers.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

Taking Diagrams Simultaneously

The following are a few indicator kinks which I have observed: The drums on certain indicators, when released after adjusting the paper, unwind with a quick, disagreeable snap, which sometimes breaks the cord. This happens when the crosshead is at or near the head end, for the drum, if then released, unwinds a full turn. Figs. 1 and 2 show an arrangement which effectually prevents this, and is easy to make.

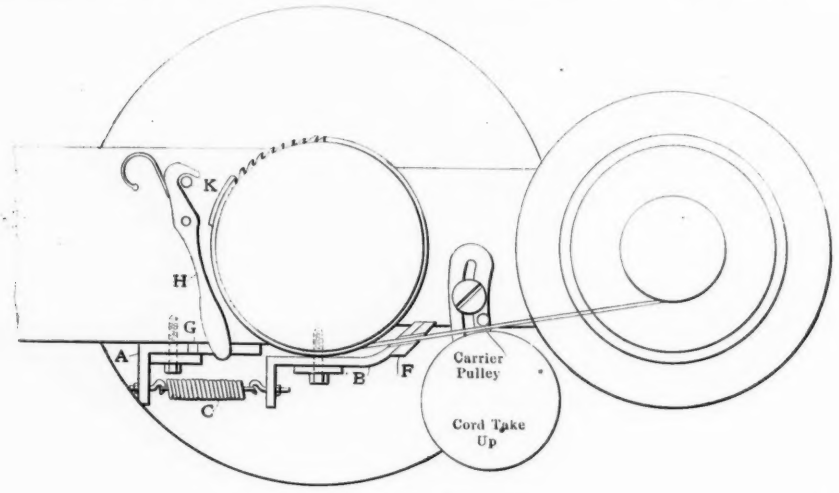


FIG. 1

It will be seen from Figs. 1 and 2 that it consists of two sliding pieces *A* and *B*, connected together by the coil spring *C*. The piece *B* has a slot *F* at the end through which the cord is passed on its way to the cord taken up. On *A* is a small projection *G*, which comes in contact with the pawl *H*. When the pawl is in use, a slight pull on piece *B*, communicating through spring *C* to *A* and *G*, will disengage it, thus releasing the drum.

If, then, a small knot be tied on the indicator cord, at such a distance that when the crosshead is near the crank and center it will come in contact with *B*, the slot being too narrow to allow its passage through, it will be seen that the drum will be automatically released when the cord is taut, and consequently there will be no snap of the drum. The small pin *K* should be dropped behind pawl *H* after the drum is stopped, then the slight pull on *B*, caused by the knot, will be taken up by the spring *C*.

Those wishing to avoid the slight distortion of the cord due to the knot could fasten on an extra cord to wind loosely alongside the other and have the knot tied in that.

In Figs. 3 and 4 is shown an arrangement by which diagrams from both sides of a cross-compound engine can be taken simultaneously. At *A*, Fig. 4, is the stem of a three-way cock, the handle of which has been removed; *B* is a solid-end sleeve, fitted loosely over stem *A*; *C C'*, Fig. 3, show a bell crank fastened to the drum *D*, Fig. 4, the arms being set 135 degrees Fahrenheit apart; *D* fits loosely over *B*; *E* is a fairly stiff flat spring and is secured to the head of the sleeve *B*.

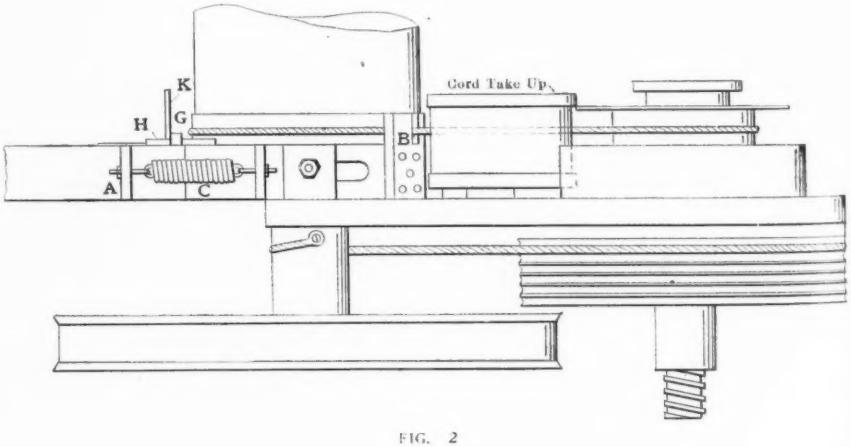


FIG. 2

It will be seen in Fig. 4 that *B* is slotted where the pin *F*, which is fastened to stem *A*, passes through it. The spring *E* passes between the two pins *G*, Fig. 3, so that a pull on the cord *N*, communicating through the spring *E* to the head of the sleeve *B*, will, when the edge of the slot in *B* comes in contact with the pin *F*, open or close the cock *A*. It will also be seen that when the three-way cock is fully opened (stops prevent it being turned any more) the bell crank *C C'* can still be moved in the same direction that the spring *E* moves it.

The rod *K*, Fig. 3, is flattened at the end *L*, and forked at the other, where it engages with the handle of the parallel motion of the indicator. It is hinged at *M*, a small flat spring, not shown, keeping it against the stop *M*, so that the pencil is held a short distance away from the drum. When the cock is wide open, due to a pull on cord *N*, *H* will be a short distance from screw *L*.

An extra pull will now cause the flat spring *E* to bend, and *H* to come under *L*. The face of *H* is at an angle of 30 degrees, and as the screw *L* slides over it the pencil is thrown against the drum. The pencil does not come in contact with the paper until the cock is wide open. The coil spring *O* is fastened by a cord to the drum *D*, and its function is apparent, viz., to close the cock and to bring the bell-crank levers *C C'* to a certain fixed position. The normal position of these is 45 degrees to the right of the perpendicular center line, so that to cause the levers to travel in the direction shown in Fig. 3 the starting pin *P* is necessary. This is loosely hinged, and falls out of the way when released of the weight of the bell crank.

When traveling in the opposite direction, or the natural direction when the

pin P is not in place, the cock first opens wide, then H' comes in contact with L, throws the pencil against the drum, and a diagram for the other end is taken.

To operate, adjust the pencil to the drum by means of the regular handles R, and screw L. Connect together the cords

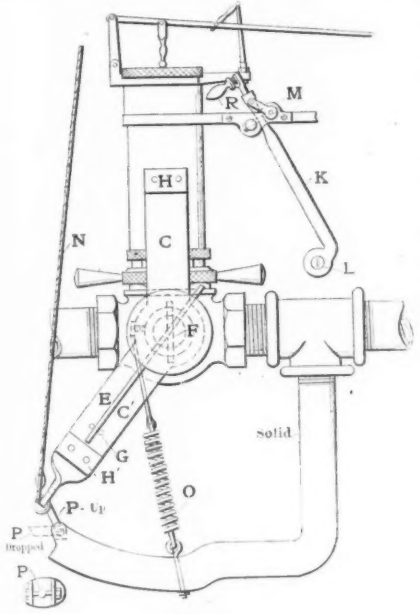


FIG. 3

of the two indicators, passing each over a swinging carrier pulley on top of each cylinder. Warm up the indicators, and then turn levers C and C' to the position shown in Fig. 3, and throw in the starting pin P to hold them there. In this position the cock is about to open. Standing between the two cylinders, pull the cord until the stops are felt; release the cord until slack, and then pull again and you have diagrams from each end of

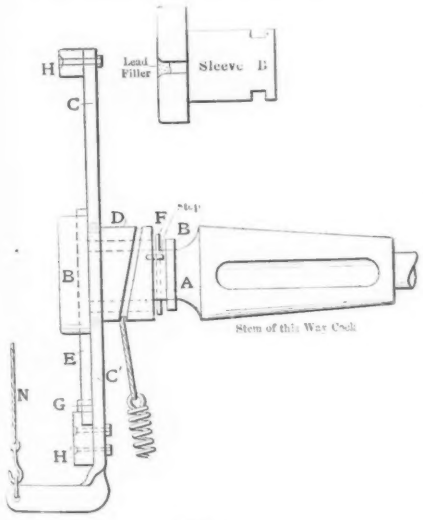


FIG. 4

both cylinders taken simultaneously as such diagrams should be taken. Now close the cocks which will be found open, due to the lost motion in the slot of the sleeve B, and take the atmosphere line.

R. O. RICHARDS.

South Framingham, Mass.

Cutting Gage Glasses

To cut a gage glass with a three-cornered file, place the file inside the glass so two of the file edges touch the glass at the point to be cut. Hold the file firmly as the glass is revolved. The file edges will scratch all the way around. Then tap gently on a piece of wood, and the glass will break where scratched.

Another way to cut a gage glass is to wet the head of a match and mark on the inside of the glass where the cut is desired. Then heat with a flame, and the sulphur from the match will burn on the inside, causing intense heat at that point. Drop water on the heated place and the glass will break.

A third method is by clamping the glass firmly and then heating the place where the break is desired by means of a string wrapped around the glass twice, see-sawing until the string wears off. Then put a drop of water on the heated part and the glass will crack. This last method is used in cutting glass tubes of large diameter.

J. C. REID.

Germantown, Penn.

Separating Oil from Water

The writer has visited several power plants, and nowhere did he observe economy being carried to such a fine point as at the Stanley works, New Britain, Conn. One feature that struck me as being unique was a scheme for reclaiming from one-half to three-quarters of the cylinder oil used in their large compound engines.

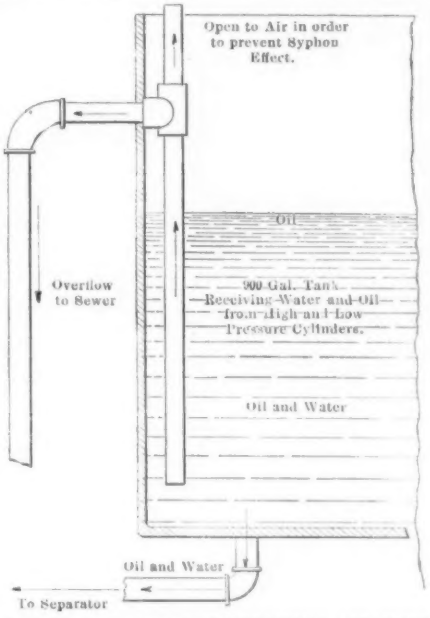
It was accomplished by means of a De Laval centrifugal cream separator, in the following manner:

A 900-gallon tank is installed in the basement, being set on standards about 4 feet from the floor. This tank receives all the water of condensation containing any oil that is caught by the traps and steam separators. The condensation from the receivers comes directly from the traps, but as a vacuum exists in the exhaust pipe of the low-pressure cylinder, the condensation is first collected in a smaller tank, and then pumped into the large tank.

A 1-inch pipe tapped into the tank feeds the cream separator with water in the same manner as though it were milk. See sketch. The water flows out of the spout, which would otherwise be skim milk, and is led to the sewer, while the oil flows out of the cream spout and is caught in a pail.

The writer examined the oil, which comes out in steady drops, and found it to be free from dirt and grit; they, however, filter it before using again.

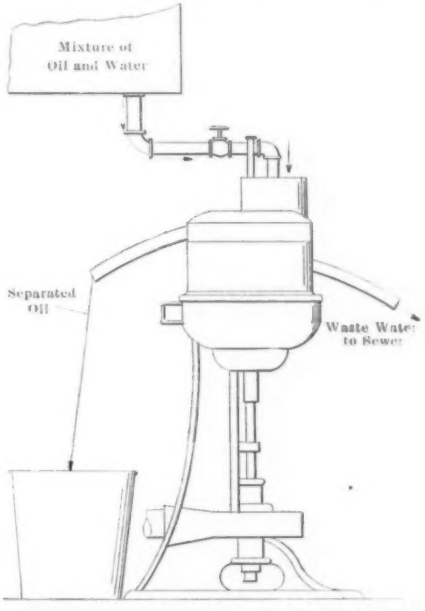
One might say that all the oil would float on top, and as long as water continued to flow into the tank no oil would be reclaimed. This is true to a certain extent, as very little oil is obtained until the tank is almost empty, then the oil runs out in a stream. I was told that with a tank full of water about one pint of oil is received for the first 100 gal-


Open to Air in order to prevent Syphon Effect.
Oil
Overflow to Sewer
900 Gal. Tank Receiving Water and Oil from High and Low Pressure Cylinders.
Oil and Water
Oil and Water
To Separator

SHOWING OVERFLOW CONNECTIONS ARRANGED SO THE OIL ON TOP IS NOT CARRIED OFF

lons of water run through the separator, but increases as the water is lowered.

To prevent the tank from overflowing at any time, or when it does overflow to carry off the oil floating on top of the water, a pipe is so placed that the water



A CREAM SEPARATOR USED TO SEPARATE OIL FROM WATER

will run off from the bottom of the tank. This pipe is open at the top to prevent the water from siphoning.

The cost of the machine is not great, and soon pays for itself.

I. P. MCAULIFFE.

New Britain, Conn.

Fuel and Boiler Room Economics

My attention has been called to an article published recently, on "Fuel and Boiler Room Economics," by Professor Benjamin, in which he states that "it is unreasonable to expect the ordinary fireman to care for more than about 200 horsepower of boilers, when the furnaces are fired by hand with soft coal."

This is very much less than is expected from the ordinary fireman in the large manufacturing plants of New England. I am quite sure that any chief engineer who should attempt to practice any such extravagance as Professor Benjamin advocates would soon lose his place.

Let me state the conditions and practice at one of the New England manufacturing concerns, where the writer has had charge of the steam plant for considerably more than a quarter of a century. We have 16 vertical tubular boilers, 61 inches in diameter, with 28 square feet of shaking grate, hand-fired with soft coal, and natural draft.

These boilers will develop 130 horsepower while burning 15 pounds of coal per square foot of grate per hour, and 200 horsepower while burning 23 pounds per hour. Our load is variable with the seasons, but is fairly uniform from day to day.

One fireman fires four boilers, attends to his feed water and hauls the ashes from the ashpits, as they are removed by the coal passers. In the winter season, while burning 270 tons (2240 pounds to the ton) per week each fireman handles from 10 to 11 tons per day, and the four boilers which he is firing develop nearly 800 horsepower. In the summer time the average weekly consumption of coal is 190 tons, or about eight tons per day per fireman, and the boiler horsepower nearly 500. The yearly average is something over 600 horsepower for each fireman. I have no reason to believe that we are doing any better in this matter of labor cost than other manufacturing concerns where the steam plant is about the same size.

The question may arise with some readers as to how well this firing is done. We make but very little smoke, no more than stoker plants, and the results from numerous evaporative tests are extremely satisfactory.

I believe these tests are as correctly made as it is possible to make them. I have frequently made an evaporative test on one boiler of ten hours' duration, while the fireman was tending three other boilers besides the one on trial, and got excellent results.

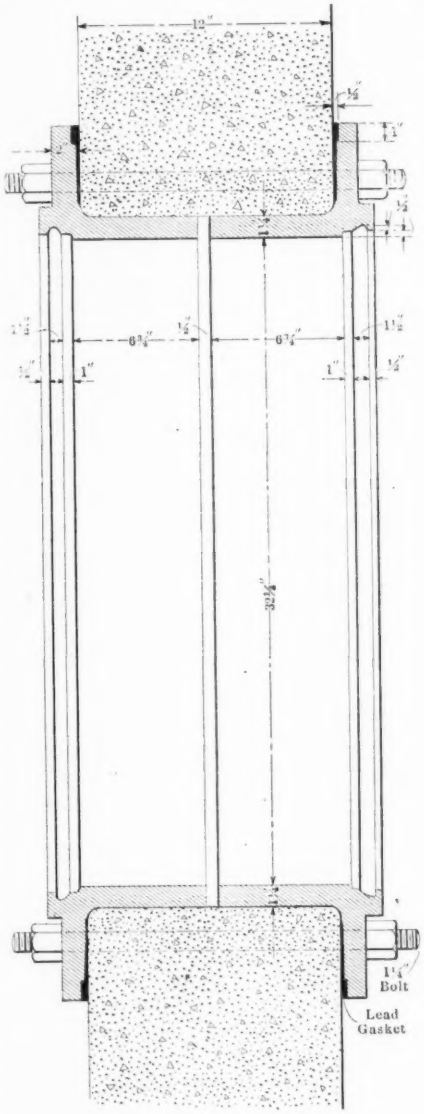
Professor Benjamin also says that underfeed stokers will probably give better results than hand firing. This was not found to be the case at this plant. Our battery of boilers was fully equipped with underfeed stokers, which were run one year with greatly increased boiler-room expense, and then removed to the back yard, where they have given us no further trouble.

CHARLES D. THURBER.

Biddeford, Me.

Stuffing Box for a Reservoir Wall

The accompanying illustration shows a stuffing-box designed to make a reservoir wall water-tight at the point where the



STUFFING BOX FOR A RESERVOIR WALL

suction pipe emerges on its way to the service pumps supplying a city water system. The wall of the reservoir at this point is 12 inches thick, and the pipe is of 30 inches nominal diameter, and about 32¼ inches outside diameter.

The stuffing-box was considered an essential as it was not thought advisable to build the suction pipe solidly into the concrete because the contraction and expansion of the pipe might eventually cause leakage around the joint, and because removal of the pipe for any cause would necessitate breaking the concrete wall.

The stuffing-box is made of cast iron in two sections, each one entering the opening in the wall from either side. They are held in place by 1¼-inch bolts set in the concrete by a templet while the wall was under construction. As will be seen, a socket, similar to that in bell and spigot fittings, is provided near the outside of each half of the stuffing-box to afford space for calking with jute and lead, as in an ordinary lead joint. The outside of the 30-inch suction pipe is 32¼ inches in diameter, and a ¼ inch clearance is allowed in the opening, making its diameter 32½ inches.

To prevent any leaks between the concrete and the stuffing-box, a lead gasket is provided on both sides. These gaskets are made 2 inches greater in diameter than the extreme outside diameter of the stuffing-box flange, and when the nuts are set up tight and compress the lead gasket against the concrete the surplus lead is bent over and calked into the recess in the flange.

GEORGE W. MARTIN.

Pine Bluff, Ark.

An Odd Repair

We recently had an odd repair job performed in our plant, which may interest some of the engineers who are operating high-speed engines. One of our 60-horsepower high-speed engines had given considerable trouble in many ways. The engine is new, only having been in service a little over a year. At the time it was set up small pin holes were noticed in the cylinder, but the engine at the start off seemed to be O. K. Six months later a pound developed for which there seemed to be no cause. If the pound was taken from one place it would show up in some other part. The engine company was notified, but nothing was done in the matter. About two months ago the cylinder began to leak and it became necessary to keep pails under the engine throughout its run.

The company then sent a man to look the engine over, and after the cylinder head and jacket were removed the trouble was discovered. The small pin holes had grown large enough to put a pencil in.

As these holes were in the counterbore, the compression was reduced, hence the unendurable pound. The repair men reamed out the holes, inserted a strip of copper, and then drove several nails in until the holes were filled. After the ends were smoothed down to the cylinder bore the head was put on and the engine has given good service since. It is interesting to think, however, what would happen if the nails should ever be drawn into the cylinder.

A. D. PALMER.

Boston, Mass.

Tank Gages and Alarms

Following are descriptions of several gages and alarms which were used with satisfaction in a pumping plant. Fig. 1 shows a section through a sewage-reservoir part of the engine room.

The float *A* is made of white-pine timber, and is guided between two suction pipes, one of which is shown in the sketch at *B*; *F F' F''* show the slide working in the guide *E*; *G* and *G'* are brass pieces, each having one end connected to an electric bell circuit; *I* is a metal strap fastened to the slide *F*.

Sewage is constantly flowing into the reservoir, which is emptied twice every twenty-four hours, or once every tide. When the pumps are started the float *A* descends with the water and pulls up the slide *F*, which is connected with it by the small galvanized-wire line *J*. As the capacity of the reservoir is marked for regular depths on the scale *K*, the moving slide indicates how fast the pumps are working. When the slide reaches *G* the metal strap presses on the brass on the other side, completing the circuit and ringing the bell, showing that the reservoir is empty.

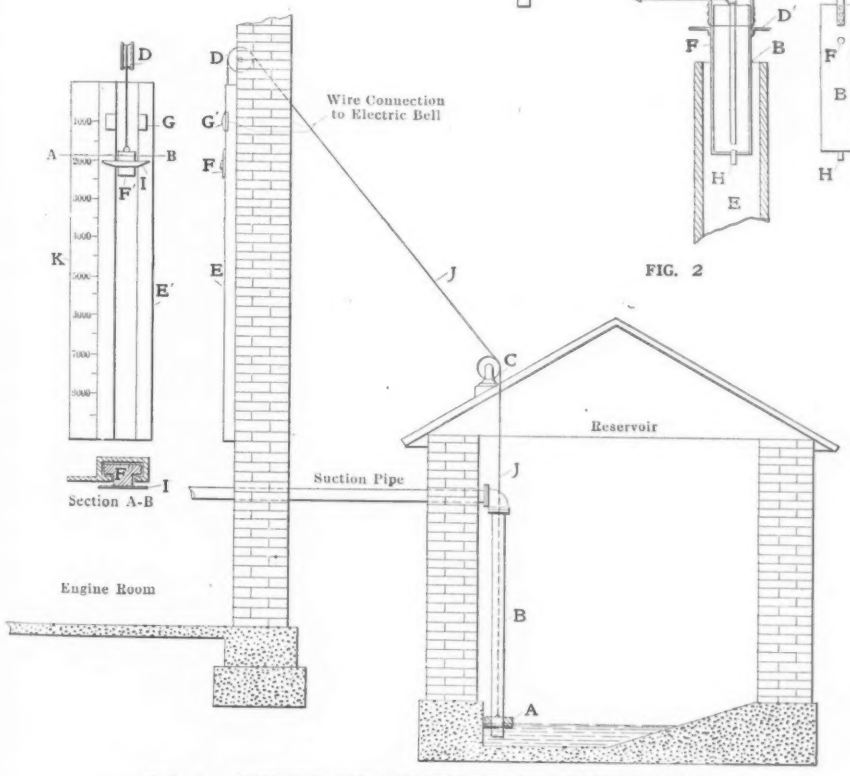


FIG. 1. SHOWING SECTION THROUGH SEWERAGE RESERVOIR

In Fig. 2 is shown an arrangement attached to an overhead tank to sound a continuous alarm while the tank is overflowing. A round bucket *B* is made of galvanized iron, having a long, stout bail *C* made of strap iron, and is suspended by a small galvanized-iron wire line over the two sheaves *D* and *D'*.

To the end of the line a slide is attached, somewhat as shown in Fig. 1. At *E* is a waste pipe, within which the bucket *B* works. The overflow pipe from the tank is piped down and into the bucket *B*, the bail allowing the pipe to work between its sides.

The action of the alarm is as follows: When the tank fills to the overflow the water flows into the bucket *B*, causing it to descend until the slide *G* comes in contact with the brasses *E*, where it is stopped by the brackets *D* on the bucket. The electric bell will continue to ring as long as the tank overflows. When the overflow stops, the water in the bucket runs out through the small pipe *H* in the bottom, and the slide *G* being weighted heavier than the bucket, the latter will ascend, ready to act again. A switch can be put in the bell wire in any convenient place, and the bell cut off as soon as it sounds the alarm, thus saving the batteries.

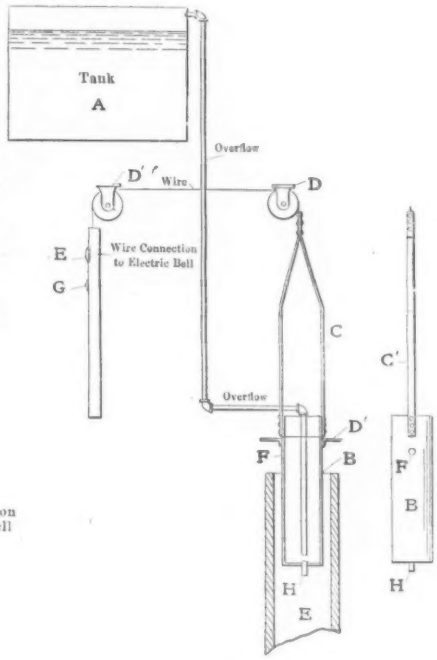


FIG. 2

Another alarm is represented in Fig. 3 and is worked by water power. At *A* is a small over-shot waterwheel made of white-pine boards, or any material at hand. At *C* is an iron pin fastened in the side of the wheel. The action of this alarm is very simple and inexpensive. The overflow pipe discharges on top of the waterwheel, causing it to revolve, which moves the end of the lever *D*, which pulls the wire *E*, attached to the old type of door bell *F*, causing it to ring as long as the tank overflows. The wheel should be incased and the waste water conducted out of the way.

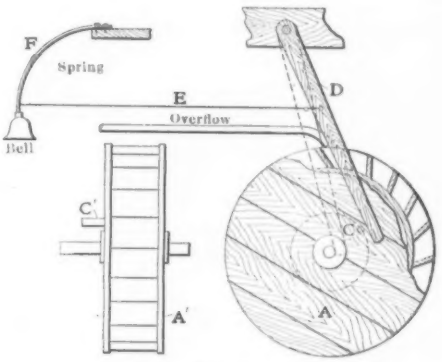


FIG. 3

We have found in our experience that blocks made of white pine make the best floats, and galvanized-wire clothesline is the best material to run over the sheaves.

J. R. HAW.

Hampton, Va.

Trouble Caused by a Bushing

A plant owned and operated by the county supplied light and heat to the court house and jail. It contained three 75-kilowatt 240-volt direct-current generators direct-connected to compound engines. The average load required the operation of but one engine at a time.

One day the chief, who had been a locomotive engineer and had never operated a stationary plant before, discovered that the governor gear was getting hot. He called the assistant engineer, who had also been a locomotive engineer, and shutting down the engine they found the grease cup empty and the brass bushing cut. After filling the cup they allowed the engine to stand idle for a time.

When it was started up, the voltage began to fluctuate, necessitating shutting down again. An expert was called in. He disconnected a few wires and charged the county $35 for his services. When the engine was again started and had been running about an hour, the old trouble returned. An all-round electrical-mechanical engineer was appealed to and he soon found the trouble. It was in the governor. The bushing had become cut so that it had to be drilled out.

P. D. LEE.

Chicago, Ill.

Interesting Boiler Repair

Boilers undergo some queer happenings, and among others was the case of a small portable boiler of the locomotive type having the crown sheet down, which happens mostly to boilers having a flat-top fire box, which is apt to become coated with mud and scale, and the heat attacks the plate.

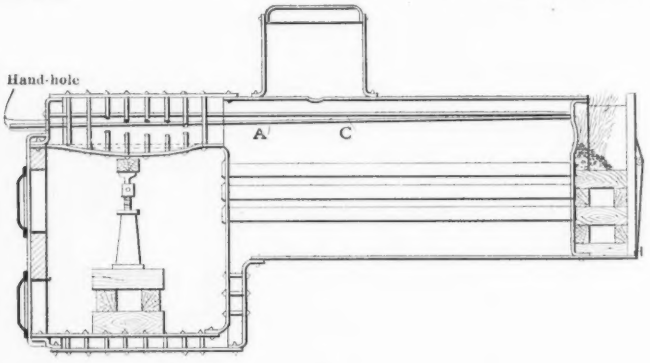


FIG. 1

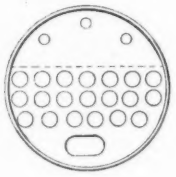


FIG. 2

A method for setting this plate back to its original place is shown in Fig. 1. A charcoal fire is built under the plate, which is heated to a dull red, and by the aid of a small jack the sheet is forced back to its original position. In many cases, longer stays have to be used, as the old stays are pulled out through the plate.

The same figure shows a bulged front-flue plate. I have set this sheet back by using a slow charcoal fire to heat the plate, as shown, and when hot by using the supporting rod shown at *A*. The head was set back by using a wooden maul in driving out the plate. When the plate was set back to its nominal place we inserted three stay rods, as can be seen at *C*, and placed in the head as shown in Fig. 2. It requires care and judgment in this work in order to be successful.

In Fig. 3 is shown another boiler job that was somewhat difficult, being one of the odd-type water-leg boilers, and having a vertical crack in the side running up to the point *N*, thus making the patch come close to the junction of the plates. For this reason, the top-plate bolt holes had to be drilled from the outside, and tapped, after which the holes in the outer plate were plugged up as shown at *M*.

When the patch was in place, the next step was to do the calking; in order to calk the top of the patch, we had to have a tool like that shown at *O*.

Figs. 4 and 5 show two ways boilers may be patched. Fig. 4 shows the proper way of placing the plate to prevent scale from accumulating, while Fig. 5 would form a pocket and cause the plate to burn out again.

Fig. 6 shows how the calking edges should not be too far from the rivet, because the plate will raise, as shown in Fig. 7, and the more calking, the worse the job gets. The patch used in general on rivets is 1⅝ inches. One of the main points in making a successful patch is to have the plate well fitted before putting in the rivets or patch bolts. Patch bolts should never be used, however, where rivets can be used, but should be used only to draw the patch down firmly when placing the rivets, so that the two plates will come firmly together.

In Fig. 8 is shown how a boiler plate

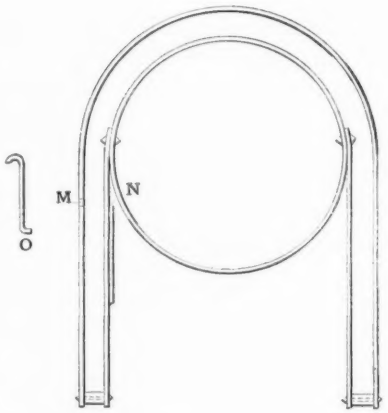


FIG. 3

FIG. 4

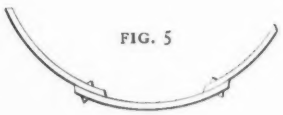


FIG. 5

FIG. 6

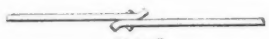


FIG. 7

FIG. 8

is often bagged by the fire. The scale forms in a small mound and overheats the plate at that point. I have found this occurs mostly where kerosene oil is being used in the boiler. It seldom happens that a plate is burned by a small accumulation of loose scale except where the oil has been used.

I have made tests on such plates and have found in some cases a thin, hard scale, not over 1/32 inch in thickness. It is quite apparent that some combination of the oil with chemical action of the water forms an almost perfect coating or insulator of water from the plates. Boilers should have careful attention in insulator to keep water from the plates.

C. R. McGAHEY.

Lynchburg, Va.

Putting a Gasket in a Condenser

Putting a new gasket in the front head (steam end) of a horizontal jet-condenser pump is a very simple thing to write about, but it is not as simple when one comes to do the job. This gasket blew out one Saturday and the chief told me to come to work Sunday and put in a new one, as well as a new valve link and crosshead. I thought I could do it in a couple of hours, but with the chief and some more help we got it done in time to have breakfast before starting up Monday morning; in other words, it took nineteen hours to do what appeared to be a very simple job.

I first removed the back heads of both the steam and water ends, took out the valve gear and pulled out all packing, after pulling out the two glands on the water end and one on the steam end. I then pulled the piston and rod out through the steam end, disconnected the steam, exhaust, suction and discharge pipes, raised the pump 4 inches from the foundation, so as to clear the anchor bolts, removed the steam end, scraped the surface of the joint and inserted a new gasket.

When connecting the pump again I found that the suction pipe had dropped down and I could not get the exhaust pipe to come anywhere near the pump. With the aid of a jackscrew and a couple of good strong men, however, we finally got the thing so we could start up.

Why do not pump builders make a joint at the front head that cannot blow or leak, and why do they not arrange the pump so that suction-valve springs and studs will not get jammed between the water piston and head when they work loose?

THOMAS SHEEHAN.

Pittsfield, Mass.

Setting the Valves of the Wright and Reynolds Engines

Referring to your issue of October 13 and Mr. Collins' answer to Mr. Niven's criticism of the article on "Setting the Valves of the Wright and Reynolds Engines," I wish to say that Mr. Collins is mistaken when he states that "the illustrations were based on Mr. Wright's old shop drawings, and were approved by J. K. Wright." I never saw Mr. Collins' productions until I received my July paper, several weeks later, when Mr. Collins called at my office to return the drawings and old catalogs which I had loaned him. I pointed out to him the mistake in his cuts, showing the steam cutoff yokes and that the swing toe in the yoke had been left out, his cuts showing an impossible construction. After explaining the use of this swinging toe and where it was shown in the detail drawings, as well as upon our old cut (Fig. 1 of Mr. Collins' article), it was readily understood and regret expressed. I only casually read the article at that time, but perusing it carefully today I think Mr. Niven is warranted in his criticism.

William Wright was a pioneer in steam-engine construction for all purposes, and his make of engine is to be found all over the country, doing as good work as and lasting longer than any engine built today; the reason they last longer is because the "niceties of construction" were so thoroughly thought out, and embodied in the engine, cost being always a secondary consideration to William Wright. He was far ahead of his time in invention and design and many good points in engines built today were his patented thoughts. It would take too much of your space to go into this detail, but I will mention one now universally used, the Tangye bedplate frame patented by him in 1873, as plainly shown upon Fig. 1 of Mr. Collins' article in the July 7 number. I am prompted in this communication simply to refute the intimation of my having any censorship of Mr. Collins' article.

JAMES K. WRIGHT.

New York City.

Description of Flash Type Boiler

The editorial under the caption, "Efficiency versus Scale," page 378, issue of September 1, has been of great interest to me, as I have been working for some time on a steam boiler, embodying the same principle, adopted by J. H. Lester and outlined in the article referred to. The illustrations show a boiler of the flash type, which I have designed, and have had in operation for some time. The boiler is cylindrical in form, 28 inches in diameter by 28 inches high, and consists of a cast-iron combustion chamber above the coils lined with carborundum on an asbestos backing and fired with crude oil.

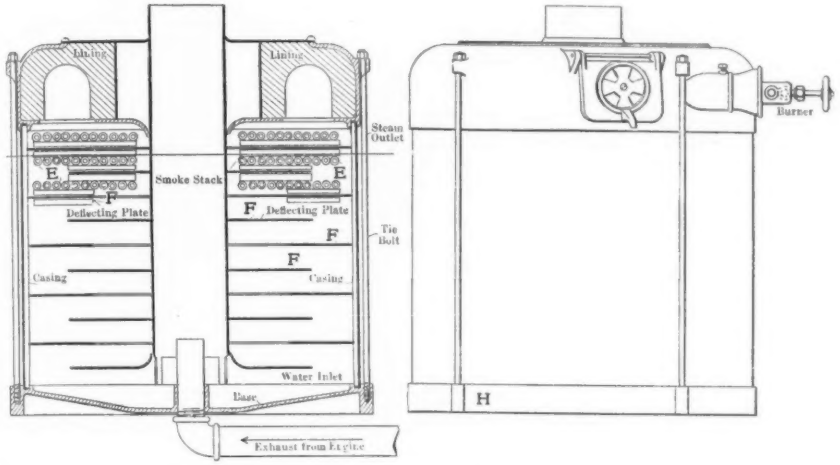


FIG. 1. CONSTRUCTIONAL FEATURES OF FLASH-TYPE BOILER

I have devised a burner which takes the oil direct from the barrel, without the assistance of a pump. Air is used for spraying and drawing the oil, until enough steam has been generated to perform this work. The air for starting is supplied by a small hand pump. Free air for combustion is drawn in by the flame through the mixing tube surrounding the burner nozzle. By heating the combustion chamber slowly with a small flame, I have, even at the beginning, very little smoke, and after the combustion chamber is hot the oil burns perfectly.

I have found by experiment that the most suitable form for the combustion chamber is the diverging-nozzle form, the narrow end being at the burner and increasing gradually in cross-section entirely around the chamber with an exit for the hot gases near the burner, the flame sweeping practically the whole circumference of the boiler. In this manner, combustion is completed before the gases come in contact with the water coils below.

The water coils, ten in number, wound spirally and connected in series, are separated by baffle plates which deflect the hot gases alternately to the center and to the circumference, thus compelling the gases to come in absolute intimate contact with the coils, until they escape to the atmosphere through a central smoke stack. The stack is not inside, but an opening is provided at the bottom of the casing for this purpose. The feed water enters the bottom coil and is forced upward through the coils, until it issues from the top coils in the form of superheated steam. Thus it will be seen that the gases, in their path from the combustion chamber to the stack, are gradually cooled by the water traveling in an absolutely opposite direction, and it has been a great surprise to everybody who has seen the boiler in operation to find that with the combustion chamber full of flame at a white heat the bottom of the boiler is at the temperature of the atmosphere, showing without any elaborate tests that practically all the heat of combustion is absorbed by the water. The loss by radiation can be only a very small percentage.

The method I employ in conveying the heat to the water is the same as used by Mr. Lester in his experiments. The apparatus, as built, is not in the best commercial form at present, but experimental work is being done constantly. I have submitted the foregoing, believing that a

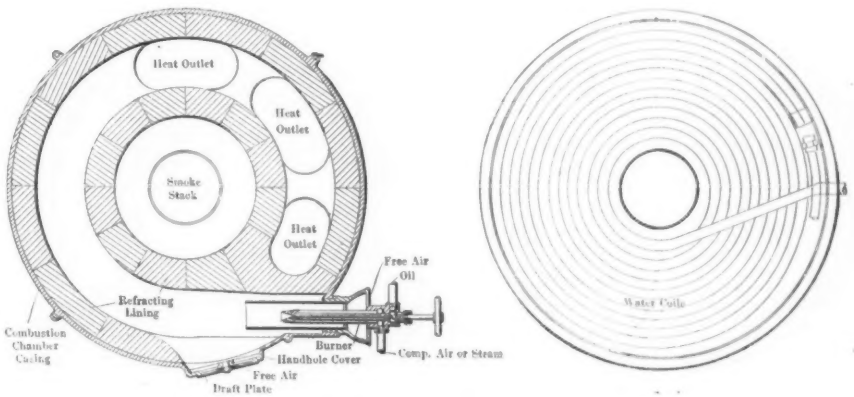


FIG. 2. SHOWING SMOKESTACK AND WATER COILS

description of this boiler will be of interest to Mr. Lester and to readers of POWER AND THE ENGINEER in general. I am willing to furnish any other additional data.

JOHN KROHN.

Chicago, Ill.

Poor Draft

Originally the draft may have been good, but after fifteen years of service the setting and brickwork were not as airtight as could be desired, and it had come to a point where an occasional load of poor coal or a dark day made it necessary to nurse the fires carefully.

On this particular day the cylinder drain cocks on the largest pumps had been left open, and as a mason had been at work under No. 3 boiler, it had been partially open all day to give him a chance to breathe. These things were noted by the night engineer when he came on duty at 4 p.m.

In front of the boilers were the chief engineer and fireman desperately at work, one with the scoop, the other with the slice bar, cursing the coal man and the whole engineering business, while the hands on the steam gages steadily dropped.

On his way to the lockers to change his clothes, the night engineer quietly closed the damper on the idle boiler, also the drains on the pump. Coming out into the fire room for work he told the day men to let him handle the fires until 6 o'clock, seeing they were both tired out, when the load would drop off.

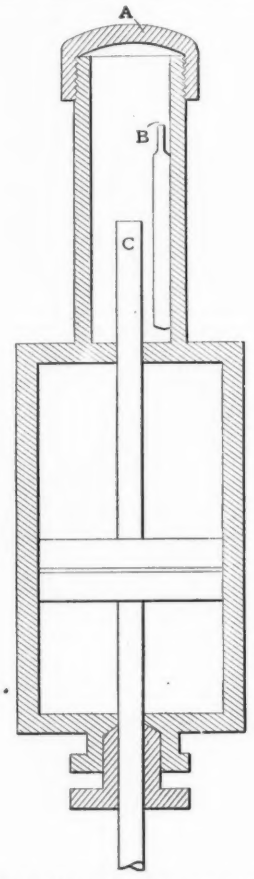
The night engineer never had been much of a fireman, but by reading engineering papers he had acquired some sound principles in regard to combustion, and he saw right away that the trouble was lack of air, while the load had been heavier than usual, on account of the open drain cocks. He went to work with the slice bar, as throwing more coal into the furnaces was out of the question for lack of room. The red-hot grate bars were covered by molten clinkers, which by diligent use of the slice bar he managed to clear from the grates in places, admitting some air. As the clinkers commenced to harden from the cooling effect of the draft it was possible to pull pieces out. By 5 o'clock the steam was up to average working pressure and the bed of fire reduced to the proper thickness. By this time the chief was in his street clothes, and came out in the fire room before leaving, and although he did not say a word, the expression on his face was worth studying. He sat down to watch things for a while, and at 5:30 the safety valves blew before the night engineer had time to close the dampers, or maybe he neglected to. During all this time not a pound of coal had gone into the furnaces, and that is how the night engineer got his reputation for being an expert fireman.

R. CEDERBLOM.

Gary, Ind.

Spanner Caused Trouble

Some time ago I read in a correspondent's letter a description of the peculiar action of a shaft governor. It seemed that the engine, when started, would sometimes race to such an extent as to preclude its use entirely, and at other times it would act beautifully until the peak of the load was reached, at which time the engine was well loaded. As the load went off, the engine would sometimes race, and at other times better regulation could not be asked for. The governor did not act in the manner we call "hunting," but it allowed the engine to increase its speed to such an extent that it had to be shut down.



SHOWING CONSTRUCTION OF DASHPOT

The governor had been carefully inspected piece by piece and thoroughly cleaned and lubricated. The universal opinion of the operators was that the engine was "hoodooed."

This governor was equipped with a dashpot of the shape shown in the illustration. It was the duty of the oiler to keep the dashpot full. When the engine stopped on the first quarter, as it was always supposed to do, the dashpot stood upright with the tail end up. To ascertain the amount of oil in it, the oiler would take off the cap *A* and insert a stick in the pipe *B*. The stick was generally the stuffing-box spanner of a small oil pump that stood a few feet from the engine flywheel.

One day the spanner mysteriously disappeared. The reader will readily guess where it went to. It was of such thickness that it could lie between the guide stem *C* and the pipe, as shown in the illustration. Centrifugal force would throw it against the cap, and it will be seen that sometimes it would assume a position where the dashpot guide rod would come up against it, thus preventing the governor from assuming a new position, and at other times its position was such as not to interfere with proper regulation by the governor. It will also be seen why the engineer failed to discover the spanner when examining the dashpot to see if anything bound therein, as it then invariably assumed a flat position along the pipe, and allowed the piston to be moved at will.

R. O. RICHARDS.

South Framingham, Mass.

Compounding Engines

It is some years since you gave your readers a treatise on the compounding of engines of odd dimensions, located promiscuously in relation to one another. For example, an engine 12x24 inches running in one part of the building, and another engine 50 feet away, of larger dimensions, say a 16x36-inch, running in another part of the building, the idea being to compound these two engines and speed them so they will serve well for all purposes that an ordinary compound engine would serve, with even more conveniences and with about as good economy.

During the past sixteen years I have obtained some fine results by compounding engines in this way. The first instance consisted in compounding a 10x16-inch Russell engine, running at 200 revolutions, with a Worthington simple-duplex pump, steam cylinders 20 inches and a 15-inch stroke. This pump represented the low-pressure engine, and was connected to a barometric condenser, of my own make, which gave from 25 to 27 inches vacuum.

When running the pump with live steam, and with vacuum, and the Russell exhausting into the atmosphere, it required eight cords of wood per twenty-four hours. By changing the valves in the pipes, and running them compound, it required five cords, a saving of three cords per twenty-four hours; this with very little expense in the arrangement.

Many times since I have made various combinations in compounding, always with good results.

L. D. COPELAND.

Los Angeles, Cal.

Test of a Municipal Electric Light Plant

In interviews published in the *New York Times* and the *New York Tribune*, on April 10, 1908, Comptroller Metz, of New York City, is made to say that it is much cheaper for the city to purchase electric current for light and power purposes from the New York Edison Company than it is to furnish it from the publicly owned plants, and that Mr. Withington, chief engineer of the finance department, had reported to him that it cost 16 cents per kilowatt-hour to light the American Museum of Natural History, while the Edison company would furnish the needed current for 3½ cents per kilowatt-hour, and that the municipal plant had been abandoned and current furnished by the Edison company substituted. Mr. Langham, chief engineer of the American Museum of Natural History, feeling that the matter had been misrepresented to the comptroller, called upon the general committee of the combined associations of the National Association of Stationary Engineers of Manhattan and the Bronx to make a thorough test of the plant. The committee made the test, and after making the proper deductions for steam used for heat, power and other purposes besides lighting, the committee showed that the actual cost to the city, for energy which the Edison company proposed to furnish, instead of being 16 cents per kilowatt-hour, as represented, actually cost less than 3 cents per kilowatt-hour. It is perhaps needless to say that the plant at the American Museum of Natural History is still in operation. A copy of the report follows:

The Report

New York, June 12, 1908.

Mr. J. D. Taylor, Secretary,
General Committee of the
N. A. S. E. Association,
Manhattan and Bronx.

Dear Sir:

The testing committee begs to submit the following report of test at the Museum of Natural History:

The committee found the plant in excellent condition in every way. Indicator cards taken from the engine at intervals showed that the valves were properly set and the engines in good order. The boilers were insulated so as to reduce radiation losses to a minimum. In general the plant can be said to be in most excellent condition and in many respects a model. Mr. Langham, the mechanical superintendent and chief engineer, gave every facility for making an accurate test without trying to influence it in any way.

Inasmuch as it is our object to make these tests as practical as possible, we will extend our comments to a few particular points.

First—From the fact that the plant is more or less of a "show plant," it must add somewhat to the expense to keep it in the extraordinarily clean and bright condition in which we found it. This is due, of course, to outside conditions and not chargeable to the efficiency of the plant.

Second—For a considerable portion of the run, the indicator cards showed that the load was too small for developing the best efficiency of the engines. It is understood by us that this condition is due to provision for future enlargements, otherwise we would recommend the installation of a smaller unit to take care of the lighter load.

The analysis of the flue gas would indicate an excess of air. We believe this was due largely to leaky dampers on the boilers not in operation and this served to reduce the flue temperature and the draft. The discovery of this fact led to its being remedied. As will be seen by the subjoined data, the cost of producing the electric current is approximately 2.69 cents per kilowatt-hour, which is about one-half the rate charged by central stations. We would further state that we believe that the present method of delivering and storing the coal could be improved so that less labor would be required.

We also learned that a large amount of electrical installation in the way of wiring, etc., is done by Mr. Langham and his staff. This is a saving which is seldom credited to a steam-plant operation.

From our observation we also learned that a great deal of work of this character is carried on by the operative staff. The automatic regulation of fire service is commendable. Test made as far as possible under normal conditions.

Wilson Van Buren,
Chairman.

Note—The gas and coal analyses were made by Prof. P. R. Menbodt, instructor in industrial chemistry at the Twenty-third street Y. M. C. A., and consulting chemist for the James Pyle Company.

Data of Test

Duration of test, 10 a.m. to 10 p.m., 12 hours.

Number of boilers, 2.

Kind of boilers, B. & W water-tube.

Heating surface per boiler, square feet, 2204.

Average steam pressure (gage), pounds, 109.5.

Feed-water temperature (degrees), average, 202.15.

Moisture in steam, per cent., 1.04.

Factor of evaporation, 1.05.

Stack area, square feet, 35.

Stack hight, feet, 130.

Coal consumed (pounds), 10,128.

Ash, pounds, 2045.

Average temperature of croton water (degrees), 64.

Average flue temperature (degrees), 388.

Coal burned, less ash, pounds, 8083.

Water evaporated, less moisture in steam, pounds, 73,292.

Equivalent evaporation, pounds, 7905.

Dry coal, pounds, 9304.

Combustible, pounds, 7887.

Water apparently evaporated, pounds, 76,083.

Coal used, No. 1 buckwheat.

Flue-gas Analysis

CO_2, per cent., 10.10.

Oxygen, per cent., 14.24.

CO, per cent., 0.46.

Nitrogen, per cent., 0.75.

Coal Analysis

Moisture, per cent., 2.68.

Volatile matter, per cent., 3.82.

Fixed carbon, per cent., 80.12.

Sulphur, per cent., 0.83.

Ash, per cent., 12.55.

8.14 per cent. of water taken out previous to test.

Coal less moisture by analysis, pounds, 9055.

Coal less ash (actual result), pounds, 8083.

Results of Test

Water evaporated per pound of coal, pounds, 7.51.

Water less moisture in steam evaporated per pound of coal, pounds, 7.43.

Water evaporated per pound of dry coal, pounds, 8.09.

Water evaporated per pound of combustible, pounds, 9.55.

Equivalent Evaporation

Water evaporated per pound of coal, pounds, 7.80.

Water evaporated per pound of dry coal, pounds, 8.49.

Water evaporated per pound of dry coal, pounds, as per analysis, 8.73.

Water evaporated per pound of combustible, pounds, 10.02.

Boiler horsepower developed, 191.

Cost of Electric Plant.

Cost of plant	$25,000
Extras	4,363
	$29,363
Deduct wiring charge from 2- to 3-wire systems, part of switchboard, etc	6,000
	$23,363
Preliminary expense of plant	1,168
Actual cost of generators	$24,531
Additional cost of steam equipment due to installation of electric plant	5,000
Cost of dynamo foundation	2,200
Cost of electric plant	$31.73

Cost of Operation.

Fixed charges, interest 4 per cent. on $31,700	1,268
Depreciation 5 per cent. on above	1,585
Repairs	150
Oil, 180 gallons per year	62
Coal, 25 per cent. of all coal used, 556 tons, at $3.60 per ton	2,000
Removal of 25 per cent. of all ashes	150
Labor, 1 man at $65 per month	780
Packing	25
Waste	10
Grate bars, etc	60
	$ 6,090

The energy generated in 1907 was 225,000 kilowatt-hours, which is equivalent to

37 kilowatt-hours for one dollar or 2.69 cents per kilowatt-hour.

Cost for Heating

There is 8,000,000 cubic feet to be heated. It requires 10,706,000 B.t.u. to heat the building to 70 degrees Fahrenheit in zero weather. The average winter temperature was 42 degrees for 212 days, and the heat transmission at this temperature per hour was 4,300,000 B.t.u.; per day, 103,200,000 B.t.u., and per winter season, 21,944,400,000 B.t.u. From each pound of coal 8000 B.t.u. was utilized in generating steam; the total amount of B.t.u. generated for heating purposes required 2,750,000 pounds of coal.

For hot-water and drying coils, 720 pounds of coal per day (not in use on Sundays and holidays) is required.

Cost of Operating Elevators, etc.

Eight horsepower each for two elevators at 60 pounds of steam per horsepower-hour for 10 hours, or 960 pounds of steam per hour, at 7.5 pounds of steam per pound of coal, equals $960 \div 7.5 = 130$ pounds of coal per hour, and $130 \times 10 = 1300$ pounds of coal per day.

For Carpenter-shop Engine

Eight horsepower at 35 pounds of steam per horsepower for runs of 5 hours per day equals $8 \times 35 = 280$ pounds of steam per hour and $280 \times 5 = 1400$ pounds of steam per day, or 185 pounds of coal.

House and Drip Pumps

Ten horsepower for 8 hours at 80 pounds of steam equals $10 \times 80 \times 8 = 6400$ pounds and $6400 \div 7.5 = 850$ pounds of coal per day.

Coal Consumption

	Pounds
Heating	2,750,000
Hot water and drying coals—720x300 days	216,000
Elevators, 366—312 = 154x1300	200,000
Carpenter-shop engine, 300—180 = 120 x185	22,200
House pumps, etc., 366—212 = 154x 850	130,900
	3,319,300
Total consumption	4,500,000
If no electric plant was in building deduct	3,319,300
	1;180,700

This is approximately 25 per cent.

Gas Men Meet

The third annual meeting of the American Gas Institute was held in New York City, October 21 to 24, in the United Engineering Societies building, 29 West Thirty-ninth street. A large number of delegates were in attendance and all were unusually enthusiastic, over the papers, perhaps, of which there were a number of exceptional interest to the "gas man," or it may be that the entertainment of the committee on arrangements had something to do with it. In the election of officers for the ensuing year, C. F. Prichard, of Lynn, Mass., was made president, and A. R. Beadle, secretary and treasurer. Of the papers which might prove of interest to Power and The Engineer readers, the following are enumerated: "The Physical Theory of Coal Carbonization," by W. H. Fulweiler; "Report of Subcommittee on Calorimetry," R. B. Brown, chairman; "Report of Committee on Pipe Standards," A. S. Miller, chairman; "Report of Committee on Electrolysis," A. G. Glasgow, chairman; "Modern Wrought Gas Pipe," by Frank N. Speller.

Electric Power in Ontario

Consul James H. Shepard, writing from Hamilton, gives further particulars concerning the proposition of the provincial government of Ontario to furnish electric power from Niagara Falls to the municipalities of that province, within a circuit of 150 miles, concerning which he says:

"The government commission, composed of two members of the cabinet of the Ontario government, has charge of this department and has given it careful study and attention. The commission has in its service expert electricians, who have spent a year or more in figuring out the possible cost to the municipalities as their share for the construction of the power line from Niagara Falls to the several points of delivery. This cost is to be shared pro rata between the municipalities entering into the scheme. It is proposed to furnish the electric energy to the municipalities at the price for which the government contracts it from the supplying company at the falls, to which is to be added the necessary expenses for maintaining the line and keeping it in working order. An extra charge is to be added for the construction of the line, which will continue to be a fixed charge for thirty years. At the end of that period the transmission line becomes the joint property of the municipalities, which will thereafter pay all necessary costs for upkeep and management, as well as for the electric power furnished, the government retiring from further control in the matter.

The Situation in Hamilton

"Hamilton is the first important point at which power would be furnished by the government, and the lowest estimate per horsepower, delivered here, is $17.80. The cost would increase to other municipalities in proportion to distance from the source of supply and the expense of construction and upkeep of the transmission line. The government contract proposes to bind the municipalities for a period of thirty years not to contract with any private company or corporation for a supply of electric power.

"In the city of Hamilton there is a corporation which began in a small way many years ago to furnish electricity derived from its steam plants for street lighting and for the street-railway system. Less than ten years ago this company utilized the water power at Decew falls, 34 miles from Hamilton, constructing a power house, machinery, buildings, and a pole line to this city for the transmission of electrical energy. Contracts were made with the manufacturing establishments to furnish them power at a price far below the cost of steam power, and now there are very few factories, and those only small affairs, that are not run by electricity. Natural gas, with which this city is supplied, furnishes a cheap power to small users.

Contract Renewals and Extensions

"The city of Hamilton is now proposing to install electric power to operate the waterworks system and the sewage-disposal plants instead of steam, and to that end a by-law was passed by the city council on July 17 authorizing a contract to be made with the local company for power at the rate of $16 per horsepower. An effort was made by the advocates of the government power system to contract with the government, but as the government could not yet make even an approximate offer at what price electric energy would be furnished, the city council accepted the proposition of the company.

"As the contract for street lighting will shortly expire, this question was also settled by by-law. The city has been paying $80 a year per lamp for all-night service during the entire year for 460 lamps. Under the new contract the city will be supplied with light at $47.50 per lamp of 2000 candlepower, and the number of lamps will be largely increased.

"These contracts are made binding for periods of five years, the city having the power of renewal at the end of each five years for twenty years by giving the company due notice. The city can abrogate the contract at the end of any five years, while the company may be held for the full period. In the contracts the city has provided for ample protection to the private users of incandescent lighting and to the manufacturers, so that the company cannot take advantage of them and raise their rates. It is probable that the city council could not have made such favorable contracts had it not been for the prospective construction of the government transmission line from Niagara Falls."—*Consular and Trade Reports.*

In the report of the N. A. S. E. convention at Denver, published in the September 29 number, it was stated that the Westinghouse Machine Company was represented by N. F. Richardson. This was an error, A. A. Rogers being the representative.

A Baby Corliss

There is a field for the small Corliss engine. Its high efficiency, as compared to that of ordinary high-speed engines, makes it desirable, even at a greater initial cost than its contemporary. Recognizing this demand, the Murray Iron Works Company, of Burlington, Iowa, has recently put on the market a small Corliss engine made in four sizes, viz., 8x18 inches, 9x18 inches, 10x18 inches and 11x18 inches. These units can be made twin when desired and fitted with extended tail rods for water pumps, ammonia compressors, air compressors, vacuum pumps or other purposes.

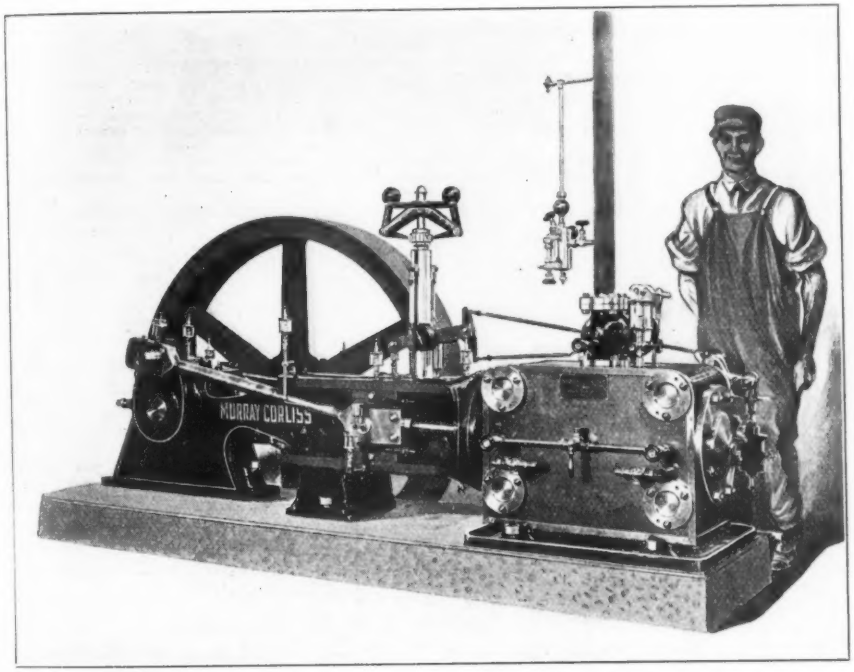


FIG. 1. COMPARE THE HIGHT OF THE MAN WITH THE ENGINE, A 9X18

The engine shown in Fig. 1 is 9x18 inches, and at the Denver convention, at which it was exhibited, attracted a great deal of attention. By comparing the size of the engine with the man in the photograph, engineers who were not in attendance will see what a toy the little Corliss really is, and especially when it is compared to the extended long-stroke Corliss engine usually found in the power plant.

Features of the New Design

In designing this small Corliss, the cylinder was made an exact reproduction of the design perfected within the last few years by the Murray company, the important features being the vertical ports, the exhaust ports passing through the exhaust valves, large steam chests with rounded corners, large exhaust chest cast away from the cylinder and a separate cylinder base. The valve gearing is laid out on the same lines as the gearing for the larger engines.

The crosshead, which is illustrated in Fig. 2, is particularly neat and substantial. It is fitted with a large pin, put in with a ground taper and provided with an oiler, also adjustable shoes with heavy clamping bolts. The crosshead is split vertically through the eye tapped for the piston rod and is fitted with two heavy clamping bolts, as shown in the illustration. The frame is cast in one piece with the guides, center foot and the main bearing, and is provided with a large bearing surface on the foundation. The general outline is shown in Fig. 3.

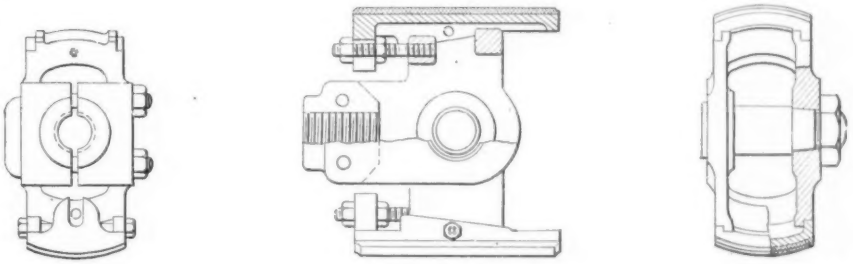


FIG. 2. THE CROSSHEAD

Hartner Governor

The governor, which is of the Hartner type, differs somewhat from usual construction, in that the springs are applied from ball to ball, and as a consequence resist the centrifugal force of the revolving parts. With this provision the governor pins carry but little more than the dead weight of the attached parts, so that the governor is sensitive in its action. The governor stem or shaft is fitted with an oil cup and cap at the upper end, by means of which the revolving parts may be oiled while in operation, and still be protected from dust. To eliminate as far as possible all friction, the pins carrying the springs are fitted with ball bearings. For adjusting the speed slightly a sliding weight is fitted to a bar on the side of the column. The governor is fitted with cut miter gear wheels just like the governor for the large Murray engines. The horizontal shaft has two bearings

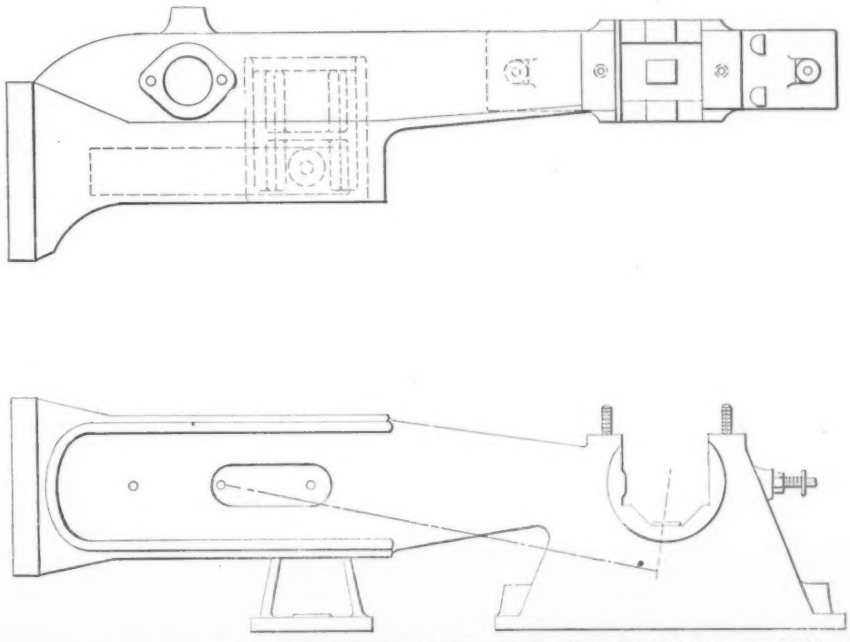


FIG. 3. FRAME CAST IN ONE PIECE WITH THE GUIDE, CENTER-FOOT AND BEARING

and the governor belt runs at a reasonable speed. The dashpot is fitted to the column and connected to the head. The shaft that turns the double crank operating the rod to the knockoff levers passes through a long reamed bearing, in which

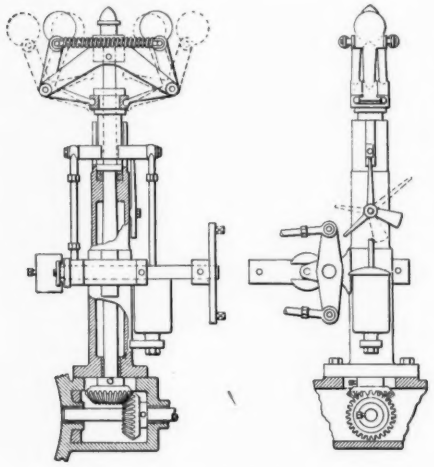


FIG. 4. HARTNER TYPE OF GOVERNOR

it lies practically balanced. A safety stop is fitted to the governor.

Concrete Foundations

A foundation plan for a right-hand 9x18-inch engine is presented in Fig. 5, with all the dimensions, and will show how very compact the engine has been made. The dimension of 6 feet 10 inches from the center line of the shaft to the center line of the cylinder will undoubtedly first attract attention as being unusually small for a Corliss engine. The other dimensions are in proportion, and the floor space covered has been brought down to nearly high-speed area. Of course, the dimensions given in the illustration should not be used for an installation without having the figures checked for the work in hand, as the drawing was simply presented to show the comparatively small amount of floor space covered by this type of Corliss.

In regard to the foundation, the accompanying table and notes and also the specifications in connection with the table will undoubtedly prove of interest. The table was compiled from "Concrete, Plain and Reinforced," by Taylor & Thompson, and was based on the use of American portland cement averaging 3.8 cubic feet per barrel of 400 pounds gross, or 394 pounds net. The specifications are as follows:

All cement should be bought to meet the specifications of the American Society for Testing of Materials, copies of which may be obtained from the secretary, Prof. Edgar Marburg, of Philadelphia, Penn. All sand, rocks or gravel and the water for mixing must be clean, no dust, mud, weeds, leaves, earth, clay or other foreign matters being allowed in the mixture. The surface of the forms should be plastered with 1 to 3 cement mortar, within 15 minutes of the time the concrete is deposited, to insure a smooth and durable surface. The concrete may be made dry and rammed until water shows on the upper surface, or it may be made wet and molded, that is, not rammed at all, but put in place with shovels and hoes. The latter method is recommended for ordinary cases, but care must be taken that the cement is not "drowned" or washed away. All surfaces of concrete that are set must be well cleaned, picked and brushed, made wet and plastered with 1 to 3 cement mortar to make a good joint, before proceeding to put in more concrete.

With first-class material and workmanship for engine foundations, where the speed, horsepower developed and other conditions are normal and the foundation rests on dry, hard ground, concrete for the outer foot of thickness may 1-2-4 to 1-2½-5 for large engines, and the inner parts or body may be made 1-3-6 to 1-3-7. If very close inspection is not practiced, it will be difficult to secure the best results. With contractors supplying the materials, the tendency is to use less cement than specified and make it too wet. With day labor or when the owner supplies the material, the tendency is to use a large proportion of cement, make it too dry and spend too much labor ramming.

CONCRETE FOUNDATIONS.

Nominal Volumetric Proportions of Cement, Sand and Stone		1.1.3	1.2.4	1.2½.5	1.3.6	1.3.7	1.4.8	Note.
Safe dead compression load, 1 to 6 months	Lb. per sq.in.	480	450	400	350	310	280	1
	Tons per sq.ft.	35	32	29	25	22	19	1
Proportions by volume	Cement in bbls.	1	1	1	1	1	1	2
	Sand, cu.ft.	3.8	7.6	9.5	11.4	11.4	15.2	2
	Stone, cu.ft.	11.4	15.2	19.0	22.8	26.6	30.4	2
Average volume of rammed concrete made from one barrel of cement, in cubic feet	50% voids	11.5	16.3	19.8	23.2	25.2	30.0	3
	46% voids	12.2	17.2	20.8	24.4	26.7	31.7	4
	40% voids	12.8	18.0	21.8	25.6	28.1	33.3	5
	30% voids	14.0	19.6	23.9	28.1	31.0	36.6	
Volume of mortar in per cent. of volume of stone		51	57	54	52	45	49	

Note 1. The loads here given apply to building work: for machinery or where there is vibratio he loading must be much less.
2. These are given in the most convenient units for estimating — 27 cubic feet = 1 cubic yard. Term "voids" relates to the space between the pieces of broken stone or gravel as loosely piled.
3. Use this line (50% voids) when the broken stone is screened to a uniform size.
4. Use this line (45% voids) for average conditions with broken stone, dust screened out.
5. Use this line (40% voids) for mixed stone and gravel.

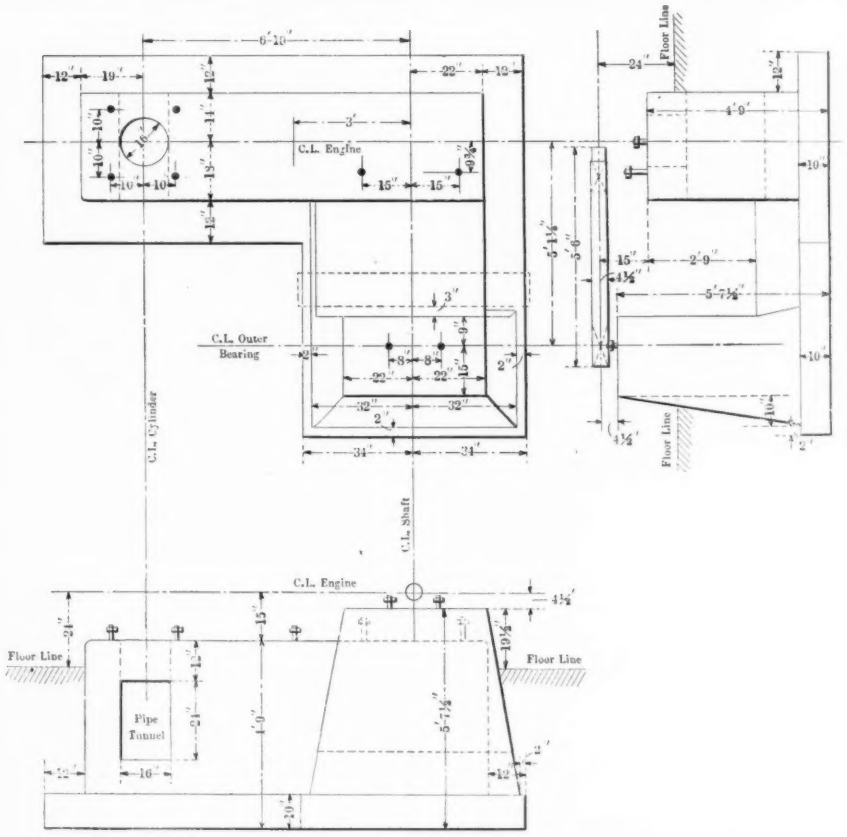


FIG. 5. FOUNDATION DIMENSIONS

Great care should be taken to see that the forms are set exactly, also every bolt and casting, etc.

Catechism of Electricity

827. *As the current passes through the armature the same way in both cases, why are the polarities of the brushes reversed?*

Because in the one case the brushes *deliver* power and in the other they *receive* it. The positive terminal of any source of power is that from which the current passes outward; the positive terminal of any power-receiving circuit or apparatus is that at which current enters.

828. *Can this be shown by a diagram?*

Yes; Fig. 272 illustrates it clearly. Here, *E* is any source of electricity—a dynamo, or battery, as the case may be. To the line which it supplies are connected a motor *M* and a group of lamps *L*. Consideration of this diagram will make it clear that polarity is determined by the source of the current, the "outgoing" terminal being positive and the "entering" terminal negative.

829. *What are the comparative advantages and disadvantages of series- and shunt-wound motors?*

The field winding of a series-wound motor consists of a comparatively few turns of large wire; the field winding of a shunt-wound motor consists of a great many turns of small wire. Series-field coils are therefore easier to wind and less expensive to insulate than shunt coils, and the wire in the former costs less per pound; this construction is therefore less expensive. Series-wound motors are more easily started, especially under heavy loads. When supplied with current at constant potential, as in the case of electric-railway motors, the speed of a series-wound motor varies inversely as the load. Special provision is therefore necessary to control the speed. Shunt-wound motors supplied with current at constant potential are very nearly self-regulating for variations of load. They may, therefore, be left to care for themselves with only an occasional inspection of bearings and brushes. On the other hand, their speed cannot be varied through a very wide range without special construction or considerable loss, and they will not start under heavy loads as readily as series-wound motors. If the current supply to a shunt-wound motor be stopped, and the motor be left connected to the supply circuit, when the current is restored the motor is more liable to be burnt out than a series-wound motor would.

Working Values of Direct-current Motors

830. *What effect has the internal heating of a motor upon the efficiency and output?*

Only a portion of the electrical energy supplied to a motor is converted into useful mechanical work, part being spent in heating the armature conductors and field-magnet winding and part in iron losses. Therefore, the heating of the windings reduces the efficiency. Since the heating is proportional to the square of the current in the windings and the output is proportional to the current in the armature, any increase in load produces an increase in armature heating equal to the square of the increase in load; there is a limit, therefore, beyond which the load cannot be increased without causing unsafe heating.

831. *What relation exists between the speed of a motor and the work performed?*

When a motor is running with constant field excitation and constant armature current, the work done is proportional to the speed. With constant field excitation and constant supply potential,

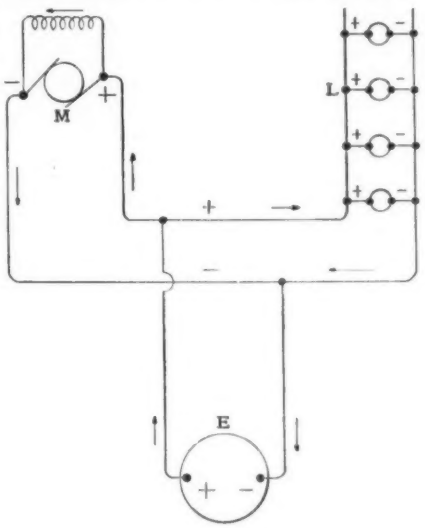


FIG. 272. DIAGRAM ILLUSTRATING RELATIVE POLARITIES OF SUPPLY AND RECEIVING APPARATUS

there is no simple direct relation between speed and work except that as the output increases the speed decreases slightly owing to the increased voltage drop in the armature, which reduces the counter electromotive force required.

832. *Explain the difference between the total power and the net power of a motor.*

The total power is directly proportional to the product of the armature current and the counter electromotive force. The net power delivered is the total power minus the loss in friction at the brushes and bearings, the loss in friction against the air and the losses in the iron parts of the motor.

833. *How is the power or output of a motor determined experimentally?*

The simplest method is by applying a prony brake to the pulley of the motor, supplying the motor with its normal full-load current and voltage, and noting the number of foot-pounds registered by the brake when the motor is running at its rated speed. If the number of foot-pounds thus found be substituted for T in the formula

$$P = \frac{T \times S}{5252}$$

and the speed of the armature in revolutions per minute be substituted for S, then the horsepower P may be easily calculated.

834. *How is the input of a motor determined experimentally?*

By measuring the voltage across its terminals and the total current delivered to it. The product of the two will give the input in watts. It may be expressed in horsepower by dividing by 746, or in kilowtta by dividing by 1000.

835. *How is the efficiency of a motor found?*

By dividing the output by the input; that is, dividing the mechanical power developed by the electrical power applied, both quantities being expressed in the same terms. Thus, if the one is expressed in horsepower, the other must also be in horsepower.

836. *What is an average value for the full-load efficiency of a motor of moderate size?*

About 85 per cent. In other words, such a motor working at full load converts into mechanical power, available for use, about 85 per cent. of the electrical power supplied to it.

837. *What becomes of the remaining 15 per cent. of electrical power supplied to the motor?*

It is used up in overcoming the friction, the armature-core losses, and heating the armature and field-magnet windings.

838. *How may the friction and iron losses be determined?*

The simplest method is to let the motor run without any load—not even a belt to a loose pulley—measure the voltage at the brushes and the current through the armature alone. Multiply the current by the resistance of the armature circuit and subtract the result from the voltage at the brushes; the result will be the counter electromotive force. Multiply this by the armature current and the result will be the watts used up by friction and iron losses.

839. *How is the power lost in heating the armature winding at full load found?*

By multiplying the square of the armature current at full load by the resistance of the armature circuit in ohms. The result will be the watts lost, and dividing by 746 will give the horsepower lost.

840. *How is the power lost in heating the field-magnet winding found?*

Either by multiplying the square of the field current by the resistance of the field winding, or by multiplying the field-winding current by the voltage at the terminals. The result will be in watts.

POWER AND THE ENGINEER

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Contents

PAGE

Characteristics and Uses of Transformers 727
The Plunger Hydraulic Elevator..... 731
Value of Flue Gas Analysis..... 733
Design of an English High Speed Steam Engine 734
Effect of Oil in Steam Boilers..... 738
The Gas Power Section of the A. S. M. E. 740
The Real Efficiency of Steam Boilers... 744
The Gas Producer..... 745
Practical Letters From Practical Men: Taking Diagrams Simultaneously ....Cutting Gage Glasses....Separating Air From Water....Fuel and Boiler Room Economics....Stuffing Box for a Reservoir Wall ....An Odd Repair....Tank Gages and Alarms....Trouble Caused by a Bushing....Interesting Boiler Repair....Putting a Gasket in a Condenser....Setting the Valves of the Wright and Reynolds Engines....Description of Flash Type Boiler ....Poor Draft....Spanner Caused Trouble....Compounding Engines 746-752
Test of a Municipal Electric Light Plant 753
Electric Power in Ontario..... 754
A Baby Corliss..... 755
Catechism of Electricity..... 757
Editorials 758-759

The Correct Heat Value of Fuel Gas for Engines

The standardization committee of the A. S. M. E. Gas Power Section is having a hard time over the two heat values of gas-engine fuels, and, in fact, the question of which is the rational value is not an easy one to determine. A gas containing hydrogen in any form, when burned in the engine cylinder, is ineffective as a power medium to the extent of the latent heat contained in the steam which is produced by the burning of the hydrogen. Of course, the steam expands and does some work on the piston, but the expansion ratio is so small and the temperature so high that the latent heat does not become available. Subtracting the latent heat of evaporation from the total heat of the gas leaves the "low" heat value, and the question at issue is whether the total or "high" heat value is the one to be considered or only that which is available for power purposes. Advocates of the "low" value argue, not illogically, that inasmuch as the engine is not responsible for the latent heat in the gas, it should not be charged with it in reckoning thermal efficiency. Supporters of the "high" heat basis argue with equal persuasiveness that the heat is in the gas and if the engine cannot utilize it, it should be debited with that inability—that the latent heat in the steam supplied to a steam engine is not deducted for the benefit of the engine, which cannot use it. At the recent meeting of the Gas Power Section, Charles W. Lummis suggested a sort of compromise plan; he would specify the total heat in the gas and also the ratio of "low" to total heats, which he proposes calling the "power factor" of the gas.

The comparison with the steam engine is not a fair one because the proportion of latent heat at any boiler pressure is constant, while the proportion of latent heat in producer and illuminating gases varies almost continuously during operation. Mr. Lummis' suggestion is excellent as a compromise, but it seems unnecessary to go to the trouble of figuring the ratio of the two heat values. It is just as easy to state both heat values as to state the "high" value and the "power factor." So far as engine performance is concerned, however, the "high" value has no more meaning than the heat value of the coal in the producer, because it has no fixed relation to the "low" value, which positively limits the amount of possible work.

The argument that the producer should be credited with all the heat in the gas is not quite as strong as the counter-argument that the engine should not be charged with useless heat. The producer, when built to supply gas for an engine, is properly chargeable with whatever deficiencies the gas may show, whether sensible heat, latent heat, tar or just plain dirt.

Rules Governing Gas Producer Installations

The National Board of Fire Underwriters has revised its rules pertaining to this branch of industry, a compliance with which means lower insurance rates on property in which gas producers are installed. One provision is that all pressure producers must be located in a building apart from other buildings, with the exception of producers, without gasometers, which have a maximum capacity not exceeding two hundred and fifty horsepower and a pressure not exceeding two pounds; these may be located in the main building, but in a separate room which is well ventilated to the outside of the building.

This restriction should be adopted not only by insurance companies, but by city and State. If the fire-insurance companies find it advisable to make restrictions in the installation of gas-producer systems, to protect themselves against loss, it is still more important to protect human life, for with the increased use of gas producers, leakage, asphyxiation and explosions will become more frequent, especially if they are placed in charge of men who do not realize that there is an element of danger connected with their operation.

The pressure system offers a greater opportunity for gas explosions than the suction system, because in the one the gas is generated and stored in a reservoir, while in the other the production of gas is governed by the demand made by the engine, and when the engine is not in operation there is practically no generation of gas.

Judging from the restrictions promulgated by the Underwriters, it will be seen that a gas producer is to be treated as a device the operation of which is considered hazardous. It is evident that placing gas producers in cellars and basements should not be permitted.

Rotary Engines

Every little while a new rotary engine, or, rather, a rotary engine with a new name, is thrust upon the notice of the public through the medium of the newspapers. Technical papers rarely consider them otherwise than as mechanical jokes.

The rotary engine is handicapped at the outset by the fact that it is not as good as the reciprocating steam engine, either mechanically or in the use which it makes of steam. These two exceedingly important points are to be overcome before this type of engine can hope to attain a

commercial success, except in a very limited field.

The rotary-engine advocate is generally led into his efforts to revolutionize the steam-engine industry by the misconception that the indirect application of force to the shaft through the crank results in a serious loss. He will show you at what a serious disadvantage the piston works with regard to "leverage" when the crank is near the center, forgetting that no form of mechanism can transmit less power than is put into it, except as it absorbs it in friction, and that if the thrust in the direction of motion is small when the crank is near the center, so also are the movement of the piston and the call for steam. As a matter of fact, the crank is a one-hundred per cent. proposition, barring friction, and we never saw a rotary engine that had any advantage over the crank in this respect; usually quite to the contrary.

The term "rotary engine," as here employed, is understood to refer to engines of the pressure type, and not to the steam turbine, which is far and away the most successful type of rotary steam engine which has yet been developed.

The only advantages that can be hoped for by substituting a more direct form of application of force for the crank and connecting rod are compactness, lightness, avoidance of centers, uniform effort and avoidance of vibration. There is a field for such an engine in automobile, motor-carriage and motor-boat work, where the absence of vibration, due to the reciprocation of masses in motion, and the starting torque which is not available with the steam turbine would make this type of motor especially applicable.

Interesting Gas Power Discussion

At the October meeting of the Gas Power Section of the American Society of Mechanical Engineers several important suggestions were made and points brought out relating to the gas-power industry. Mr. Doherty, the energetic chairman of the meetings committee, in a communication which is printed in abstract on another page, urged that so-called failures of gas engines or producers should be made public and fully explained, for the benefit of the industry at large. We have several times inveighed against the short-sighted policy of attempted secrecy and self-delusion followed by some builders of gas-power apparatus, but we have never ventured to advocate Mr. Doherty's heroic plan, although there is no doubt that the results in the near future would justify it. Presumably Mr. Doherty will be characterized as a rabid partisan of the steam-engineering industry by the short-sighted ones aforesaid, but that will scarcely ruffle his equanimity, nor will it alter the fundamental fact that buyers of machinery are generally attracted by frankness and repelled by the attempted concealment or whitewashing of mistakes. If a manufacturer's record is so bad that he doesn't dare tell the whole truth about it, he has no place in engineering.

Mr. Doherty's assertion that a gas engine has "much lower efficiency" at all loads other than the maximum seems to us rather extreme. A single-acting vertical engine tested not long ago showed 28 per cent. at full load and 24 per cent. at half load, on the basis of brake horsepower; this does not accord with the statement, although "much lower" is susceptible of elastic interpretation, of course.

One of the suggestions which appealed strongly to us was that the Gas Power Section should take especial pains to prevent inaccurate statements and incomplete facts from being presented at its meetings. Engineering societies are quickly rendered unauthoritative, if not actually ridiculous or discreditable, by accepting papers which contain half-facts (the favorable half), misstatements, assumptions which will not stand analysis, or assertions made merely with commercial motives or for personal advertising purposes. The gas-power industry has suffered quite enough from misrepresentation and reckless exploitation; that sort of thing should never be allowed to get into the Gas Power Section proceedings.

High Vacuum Economics

In steam-turbine operation a high vacuum means economy. Theoretically, this statement is easily proved, and it has been so often verified under actual working conditions in the power plant that it is accepted without hesitation. The only question that arises in practice is to determine how high a vacuum it is practicable to carry without incurring more expense for auxiliary equipment and increased difficulty of operation than the extra economy is worth.

An increase in vacuum from twenty-six to twenty-nine inches of mercury necessitates a large increase in the size of condensing apparatus required. The cooling surface must be doubled, the amount of cooling water increased in greater proportion, and the dimensions of the air cylinder of the dry-vacuum pump enlarged to twice those of a pump for moderate vacuum, or perhaps two pumps used in series. This, of course, means a high first cost, more money for depreciation expenses, and an additional sum to cover the interest on a larger investment. These must be pitted against the gain in economy obtained by the extra three inches of vacuum.

From observation of daily operation it would appear that ample cooling surface is in most cases provided, that the amount of cooling water is doubled and that frequently three times the quantity is required at the higher vacuum, due to the small difference in temperature between the steam and water. Variations in load and initial temperature of the water vary the amount of water necessary to meet the demand, and to comply with good practice an independent pump is usually installed, so that its feed may be regulated as needed. Formerly, the pumps for removing the condensed steam and circulating the cooling water were connected. For ordinary vacuum this practice was found desirable, and even for a higher vacuum there is no serious objection, if special precaution is taken to see that each pump is properly proportioned.

In the average plant the capacity of the dry-vacuum air pump has been found sufficient, although more difficulty from the leakage of air might naturally be expected as the vacuum is increased. The trouble from this source has been lessened to a considerable degree by making the connection between the turbine and the condenser as short and direct as possible, and connecting the pump and condenser with the same idea in view. The single-cylinder air pump with its large clearance space made it extremely difficult to obtain a high vacuum, but by running the pumps in series and compressing the air twice or even three times, satisfactory operation has been obtained.

More power is required for the circulating and vacuum pumps maintaining high vacuum than for the same or similar apparatus producing an ordinary vacuum; but even with a high vacuum the power demand is not excessive and is usually a very small percentage of the power developed by the turbine. In one particular instance of a large plant it is well under one per cent.

In the condenser itself there has been vast improvement. From a box of tubes capable of condensing only six pounds of steam per square foot of surface per hour, the uptodate countercurrent condenser with deflecting plates to carry off condensation from the various banks of tubes is now capable of converting into water from fifteen to twenty pounds of steam on the same surface, a significant figure when first cost, space occupied and maintenance charges are considered.

While there is no advantage in reducing the condenser pressure below four inches of mercury for a reciprocating engine, experiment shows that the steam consumption of the turbine is reduced three per cent. for every raise of 0.4 inch in vacuum. Naturally such data call for a high vacuum, and the higher the better. With the improved apparatus referred to, the initial cost of a high-vacuum installation should be less instead of greater, the cost of maintenance reduced, less space occupied, and with the little defects inherent to new designs eradicated, operation should entail little more complication than for moderate-vacuum conditions.

Inquiries

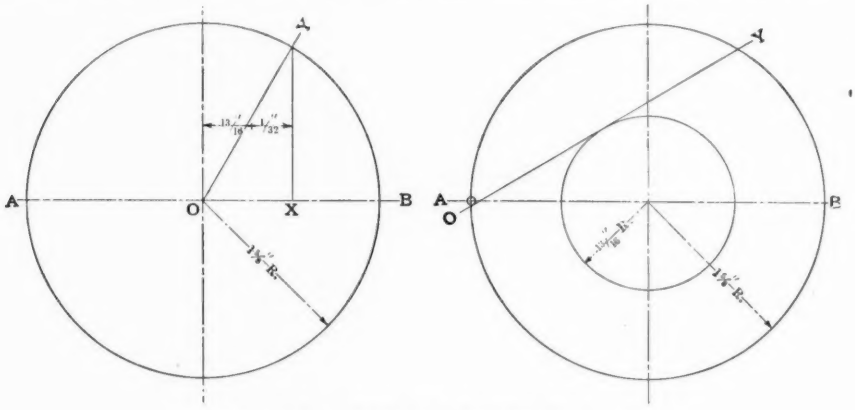
Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

Finding Lap, Maximum Port Opening, etc.

The travel of a slide valve is 3¼ inches, the lead is 1/32 inch, and the angle of advance is 30 degrees. Find the lap, the maximum port opening, and the percentage of stroke completed by piston when steam is cut off.

J. C. S.

If you will lay out a circle of a diameter equal to the valve travel and draw a horizontal line *A B* through the center, you will be ready to solve the problem. Advancing the eccentric 30 degrees moves the valve to a position where it has 1/32-inch lead; hence, it must have moved the valve the amount of lap plus 1/32 inch. Now on the circle draw a radial line *O Y* 30 degrees in advance of 90 degrees, for with a valve without lap or lead the eccentric would stand at 90 degrees from the crank, and advancing it 30 degrees would place it 120 degrees ahead. Drawing a line *X Y* from the 30-degree advance line, perpendicular to the diameter, will show how far the valve has been moved to take off the lap and give the lead. If your work has been done accurately, you will find that the valve has moved 13/16 plus 1/32 inch, which gives a lap of 13/16 inch. The lap and travel being known, the other points can be found by using Sweet's valve diagram. Draw a circle equal to the valve travel and from the same center draw a circle with a radius equal to the lap of the valve. At the intersection of the diameter *A B* with the circumference, draw a circle with a radius equal to the lead; then with a rule draw a straight line *C T* tangent to the lead and lap circles. When the cutoff takes place the crank pin will stand at the intersection of the line *O Y* and the circumference.



FINDING LAP, MAXIMUM PORT OPENING, ETC.

Cause of Jogs in Expansion Lines

The accompanying diagrams (Fig. 1) were taken from a Corliss engine. I cannot understand what caused the jogs in the expansion curves at the points designated by the arrows.

F. C

As the jog or irregularity in the expansion line occurs at the same hight at each end, it is evident that something interfered for an instant with the descent of the pencil at this point. In indicators with a pencil bar of the style shown in Fig. 2, too heavy pressure of the pencil against the drum would bend the pencil bar until it struck the pivot of the parallel-motion lever, as shown at *A*. That was the probable cause in your case.

Drop in Back Pressure Line

Herewith are indicator diagrams from the high-pressure cylinder of a compound engine. Will you please tell me what causes the drop in the back-pressure line at the beginning of the stroke?

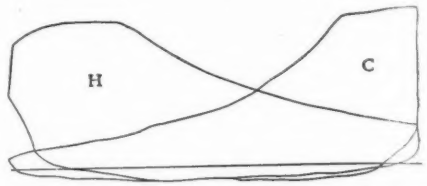
W. E. S.

The drop is not a fall of pressure; the lowest part of the curve indicates the true receiver pressure, and the rest of the line denotes a rise of back pressure in the cylinder due to insufficient exhaust-port area. This rise is caused by the piston forcing the exhaust steam into the receiver faster than it would naturally flow.

Cause of Reverse Curve in the Diagram

What is the cause of the reverse curve in the compression line on the head end of the accompanying diagram?

J. C. G.



WHY THE REVERSE CURVE IN THE HEAD-END COMPRESSION LINE?

It is due to a combination of stretching drum cord and lost motion in the reducing rig.

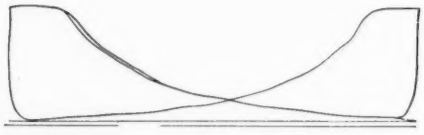


FIG. 1. DIAGRAM FROM CORLISS ENGINE

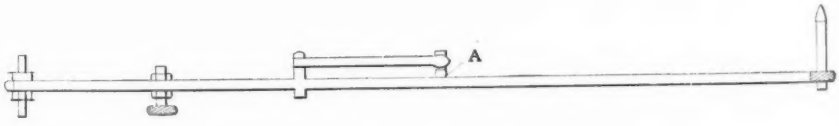
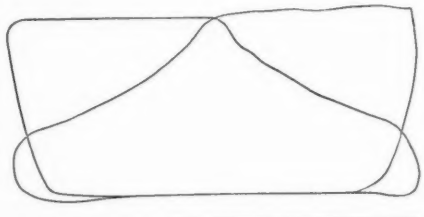


FIG. 2. ONE TYPE OF INDICATOR-PENCIL BAR



SHOWING DROP IN BACK-PRESSURE LINE

Obituary

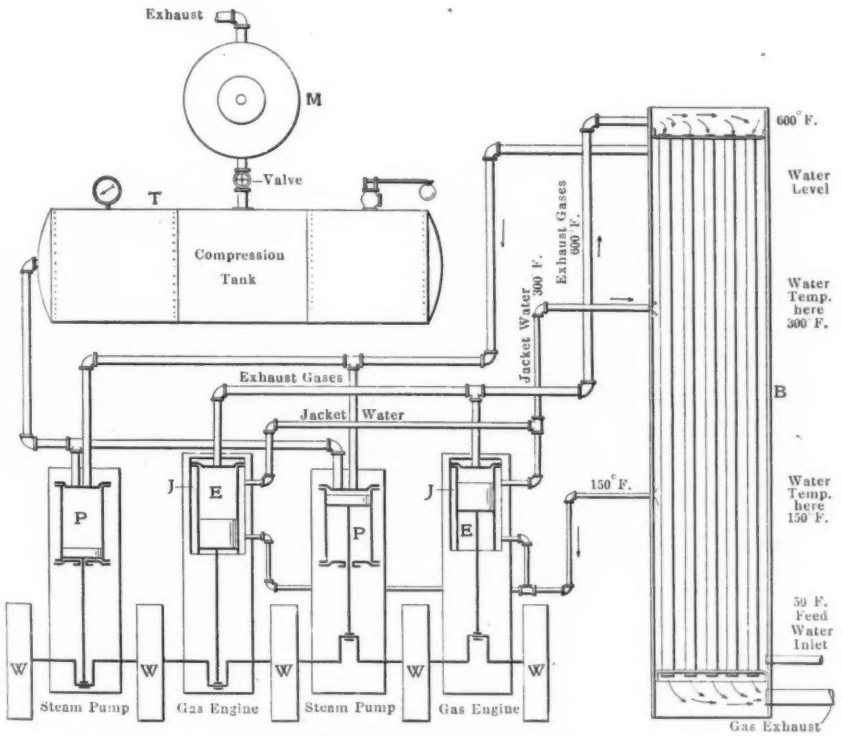
Frederic A. C. Perrine, a well known electrical engineer, died October 20 at his home in Plainfield, N. J., of Bright's disease. He was born at Freehold, N. J., in 1862, and was graduated from Princeton. Later he became professor in electrical science at the Leland Stanford University, California, and subsequently president of the Stanley Electrical Manufacturing Company, at Pittsfield, Mass. More recently he was a consulting engineer, with offices in New York. He was a member of the American Institute of Electrical Engineers, and the author of several books on electrical science, the best known of which, perhaps, is "Electrical Conductors," which contains a very comprehensive discussion of transmission and distribution lines.

Personal

H. G. McConnaughy, New Jersey representative of the Dearborn Drug and Chemical Works, was director of exhibits at the recent convention of the American Street and Interurban Railway Association, and he performed the duties attendant upon that office so satisfactorily that pleased exhibitors presented him a gold watch and fob. In addition, each mail has since brought him letters of commendation.

The Torridoor Duplex Force Power Generating System

The apparatus described by the accompanying engraving is one of the concrete applications of the many ideas which Dr. J. M. W. Kitchen, of East Orange, N. J., has evolved for the reduction of heat waste in power- and heating-plant work. Impressed with the small percentage of the heat contents of the coal which was usefully applied in the heating of greenhouses for the culture of orchids in which the doctor was interested, he has been led into a study of the broad subject, and the evolution of a comprehensive plan for carrying back into the system by countercurrent and regenerative processes much of the heat which is customarily allowed to escape. One of the methods by which he proposes to make available the large volume of heat which is rejected by an internal-combustion plant at a comparatively low temperature is to use the energy of the prime motors to compress steam, generated at the available temperature and corresponding low pressure, to the pressure and temperature customarily used, and he would like an expression from our readers as to the advantages to be derived from the process.



THE TORRIDOOR GENERATING SYSTEM

The application is the so-called "Torridoor Duplex-Force Power Generating System," partially illustrated in the accompanying drawing, which presents some of the more prominent features of the invention. These are a plurality of internal-combustion engines, each of which is represented by the character *E*; a vertically disposed economizer boiler *B*, a storage tank *T* and a steam turbine *M*. In completely equipped installations there would also be comprised in the system a gas generator suited to the fuel used, a water purifier for utilizing exhaust steam in purifying the water, a combined turbine condenser and air heater, in which the vertical countercurrent principle is used in heating air for combustion and cooling feed water to a low enough temperature to pick up low degrees of heat in the economizer boilers, means for conserving the heat of gas generation in steam-motive force, and means for superheating the steam.

Operation of the System

The gas generated is burned exclusively in the internal-combustion engines *E*, and these actuate the steam-compression pumps *P*. Steam is generated from the heat of the jacket water and of the exhaust gases in the economizer boiler *B*. This steam is conveyed into the cylinders of the steam pumps *P*, overcoming the friction of the pistons and conveying the balance of its force to the flywheels *W*, and is then given increased compression on the return stroke of the pumps by the force of the explosion of the gas in the internal-combustion engines. The mechanically compressed steam is forced into the pressure equalizing and accumulating tank *T*, from which it is drawn as needed to actuate the prime mover *M*, or to do other work.

The jacket water is run into the economizer boiler at a level where the temperature is approximately the same as that of the water in the boiler at that level. The exhaust gases of the highest temperature enter the boiler at the highest level and are forced downwardly and out through the exhaust pipe at the bottom of the boiler, the specially cooled feed water entering at the bottom and taking up the heat of the gases progressively. With this arrangement for gas and water travel, substantially all the heat escaping from the engines *E* can be turned into steam.

The claimed advantages of the system are: The coupling up of the forces of explosion and steam expansion, as generated in any number of units, in an effective and convenient way. Entire avoidance of the jar and shock of the force of explosion, as when a rigid transmission is used, the cannon-ball-like explosive force being changed into a smoothly flowing and easily controllable force. The internal-combustion engine units may be of the most simple, inexpensive nature, and the power of any plant can be increased by adding to the generative units. More or fewer of the units may be thrown out of commission with decreases in load, and much friction and use of lubricating oil avoided.

Blake's Automatic Valve Motion

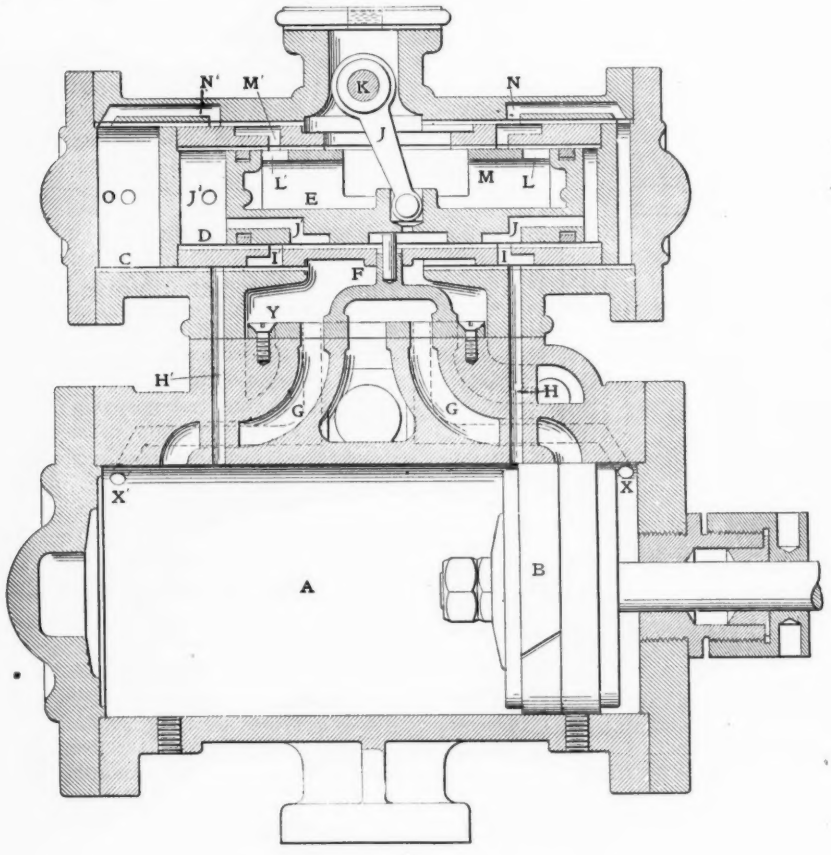
A new patented automatic valve motion which has been designed for steam pumps is shown in the accompanying illustration. The valve motion consists of a steam chest inclosing two reciprocating cylinders, one within the other, in which is a plain D slide valve connected to the outer cylinder, as shown. The inner piston or auxiliary piston is shown at *E*. These pistons are held in their relative positions by a steel pin driven into lugs on top of the slide valve *F*, and passing through the valve piston *D* engages in a longitudinal slot in the bottom of the auxiliary piston *E*.

The illustration shows the main steam-piston head *B* at the extreme end of the inward stroke of the main steam cylinder *A*, and the various pistons in readiness to take steam to make their return stroke from reversing the slide valve. This position of the parts being plain, it is evident that the following references to letters will apply to the right-hand end of the cylinder diagram. It will be noticed that the small port *H* is uncovered by the rings of the main piston head *B*, which opens communication between the live-steam end or the main steam cylinder *A* and the clearance of the auxiliary valve *E* through the ports *H*, *I* and *J*, throwing the auxiliary-valve piston *E* to the left and exhausting through a port corresponding to *J'*, shown at the other end of the main valve piston *D*, which port passes through the wall or side of the valve piston *D* into the chest *C*, and down into the main exhaust. The port *J'* is placed at a proper distance from the end of the cylinder to allow the auxiliary

piston E to pass over it to cut off and entrap steam, thus forming a cushion and preventing striking the head.

It is evident that the main piston head D must complete a full stroke before any move can be made to reverse this motion, and that the valve pistons are cushioned by entrapped steam, and not by live steam.

The inside of the auxiliary piston E is constantly supplied with live steam direct from the steam chest, and when shifted in its position to the left the ports L', M' and N' will come opposite each other and open communication between the steam chest and the clearance of the main valve piston D, causing it to make its stroke and exhaust through a port corresponding to port O, which port passes into the wall or side of chest C, and down into the main exhaust. The port O is placed at a proper distance from the end of the cylinder to allow the main steam-valve piston D to pass it to cut off and entrap steam, thus forming a cushion.



BLAKE'S AUTOMATIC VALVE MOTION

In the shifting to the left of the main valve piston D the slide valve F is reversed, thus admitting steam to the opposite end of the main steam cylinder A and reversing the main piston head B, which travels until the small port H on the other end is passed, when an identical set of ports on the opposite end of the valve pistons will again reverse the motion in the same manner as described.

The main steam cylinder A is commonly called a five-port cylinder, and it will be observed from the diagram that communication between the exhaust end of the main steam cylinder A and the main port G is entirely cut off, while the small or fifth port X on the exhaust end of the cylinder is covered on top by a lug on the side of the slide valve F, thus preventing the escape of exhaust steam through the port X'. This entraps the steam and forms a cushion on the main piston head B and prevents it from striking the cylinder head. When the slide valve F is reversed, steam is admitted both to port G and port X', but as communication between the port G and the cylinder is cut off, the only steam admitted to the cylinder must pass through the small or fifth port X', thus allowing the main piston head B gradually to assume its motion until the rings uncover the main port G, when the piston takes full speed. This gives a quiet and easy reversing of the main piston head B.

The steam cylinder is provided with a removable slide-valve seat Y, which is secured in place by screws. The lever J is attached to the auxiliary-valve piston and fixed upon a shaft K which passes through the wall of the steam chest and is fitted for a wrench, thus giving absolute control of the valve mechanism from the outside.

The advantages of this type of valve movement are claimed to be as follows:

A cushion of entrapped steam so perfect that while laboring under a hydraulic pressure the suction of the pump can be thrown open to the atmospheric pressure and under the resulting excessive rate of piston speed it will not strike or pound; that a positive operation is obtained, there being no dead point, and even if the valves were reversed when the pump is at rest, they will immediately resume a proper position upon admission of steam; that a much shorter pump is obtained by reason of having no valve movement crosshead, thus increasing the weight to a considerable extent as well as the floor space required; that a slide valve of the plain D-pattern without tendency to wear to a convex face, the main slide-valve piece being made removable so that it can be replaced with little expense when worn, and thus a much steadier stroke can be obtained because all steam cylinders are made with five ports.

There are no outside gear, very few working parts, no adjustments to make, a high speed obtained without noise, and a low speed without stopping. This device is made by the Blake Pump and Condenser Company, Fitchburg, Mass.

The "Western Electrical and Gas Directory" for 1908, published by the Blanchfield Publishing Company, San Francisco, Cal., lists a total of 1021 electrical, gas, railway and kindred companies, including a comprehensive record of companies controlled and absorbed by others, in the States of Arizona, California, Nevada, Oregon and Washington, together with complete information concerning the organization and engineering details of all companies constituting the industry. Of this total, 686 companies are devoted to the generation, transmission, distribution or utilization of electric light and power; 145 are gas companies, and 190 are electric-railway companies. In all, nearly three-quarters of a million kilowatts of electrical energy is being actually generated or is in process of installation for the operation of the electrical industries of the five States named—that is, approximately one million horsepower. In addition, the gas companies of these States annually produce close to fourteen billion cubic feet of artificial gas. The directory is so arranged that the names of companies, firms and individuals engaged in the electrical and gas industries located within the States of Arizona, California, Nevada, Oregon and Washington are given alphabetically, not only by cities and towns under their respective States, but also under the industry or industries which they represent, i.e., the "Gas," "Electric Light and Power," and "Electrical Railway" industries. In the alphabetical list of companies by industries, asterisks are used to indicate whether each particular company is independent, has been absorbed, or is controlled by another company, while the body of the directory particularizes in this respect. It costs $10.

Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

Davis "Class C" Automatic Stop and Check Valve

In modern practice where a number of boilers are installed in battery, all delivering their steam to one main header, should a tube blow out, a crown sheet fail, or accident of any kind occur to the steam-generating apparatus, the steam from all of the boilers would be given an opening to the atmosphere, if some means were not taken to prevent it. Therefore, in high-class plants where continuity of service is of the greatest importance, it is customary to install some form of non-return valve which will isolate a boiler in case the current of steam is reversed from that in which it normally flows.

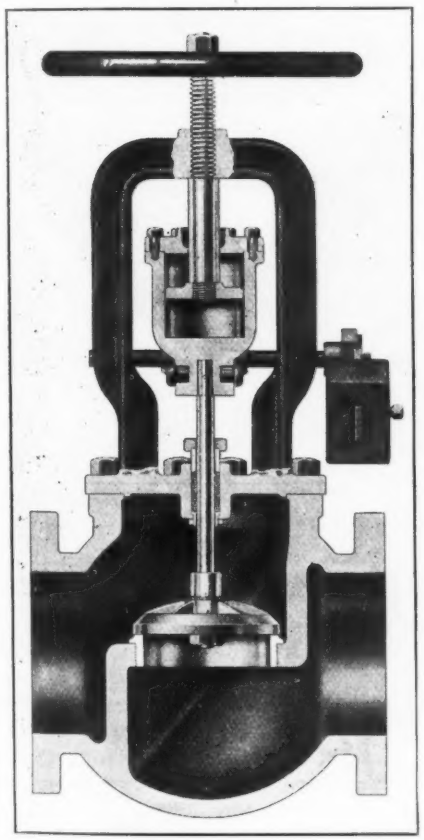


FIG. 1. DAVIS "CLASS C" STOP AND CHECK VALVE

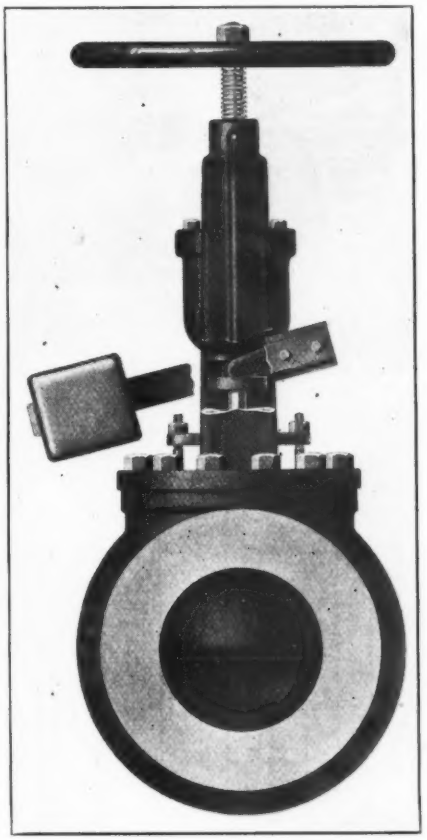


FIG. 2

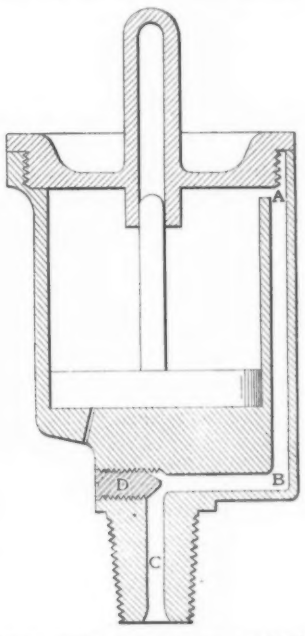
The Davis "Class C" automatic stop and check valve, shown in section in Fig. 1, was designed especially for this purpose. It is placed in the steam line leading from the boiler to the header and is governed entirely by the current of steam as it flows from the former to the latter, pressure not affecting its operation in any way. The valve body is made of cast iron and is extra heavy, to withstand pressures up to 250 pounds per square inch. The disk and seat are made of bronze, are renewable and regrinding. A feature of this valve is the oil dashpot provided on the valve stem, its location being such as not to be affected by the heat of the steam; this feature is important, as it insures a valve which is exceptionally free from sticking or other common difficulties. A hand wheel is provided, by the use of which the valve may be permanently closed, but it does not interfere with its automatic operation when required. The dashpot makes the valve noiseless and easy in action. When in operation the valve remains open as long as the steam is passing in the proper direction, but in case the current of steam is reversed the valve immediately closes.

Fig. 2 shows the connection of the counterweight and lever to the valve stem. The weight is set in such position as to just balance the upward pressure on the disk, due to the area of the valve stem being subtracted from its effective upper area. The position of the weight arm offers a ready means of determining whether the valve is operating satisfactorily and provides a means of testing the free movement of the valve and stem. Metallic packing is used in the valve-stem stuffing box.

This valve has recently been brought out by the G. M. Davis Regulator Company, 144 Milwaukee avenue, Chicago, Ill.

New Loose Pulley Oil Cup

The accompanying engraving shows a new oil cup for loose pulleys, made by the Lawson Manufacturing Company, Buffalo, N. Y., which is claimed to solve the loose-pulley oiling problem. The cup consists of three parts, a body, a piston or plunger, and an oil-tight cap. In operation it is very simple. The cup after being put in place is filled with ordinary lubricating oil. The centrifugal force due to the rapid revolving of the pulley throws the piston outward, thus driving the oil through the channel *A B C* to the shaft on which the pulley revolves. The flow of oil is controlled by the screw *D* and is



SECTIONAL VIEW OF LAWSON LOOSE-PULLEY OIL CUP

regulated according to the speed of the pulley. When the pulley stops, oiling ceases at once, regardless of the position of the cup, and begins as soon as the pulley revolves. Where this cup is attached to pulleys of very high speed a helical spring is inserted above the piston to counteract in a slight degree the effect of centrifugal force. It is claimed that the cup needs to be filled but once a week. It is made in two sizes. Pulleys having a diameter of from 6 to 12 inches require size No. 1. Pulleys having a diameter of 13 inches or more will take size No. 2.

General Electric Direct Connected Electric Generating Outfit

The General Electric Company is building an attractive line of steam engines and direct-current dynamos direct-connected and mounted on a common base frame, as illustrated by Fig. 1 herewith. These outfits are built in sizes ranging from 2½ to 75 kilowatts output, and although originally designed for marine service, their simple, rugged construction and quiet running have resulted in their application to all kinds of service.

The generator of the set is built on exactly the same lines as the company's standard direct-current machines of larger sizes. From 2½ to 7 kilowatts the field-magnet has four poles and from 10 kilowatts up, six poles. The armature is of the slotted-drum type, with form-wound and individually insulated coils, lap-connected to the commutator.

The engine is a single-cylinder piston-valve machine especially designed for

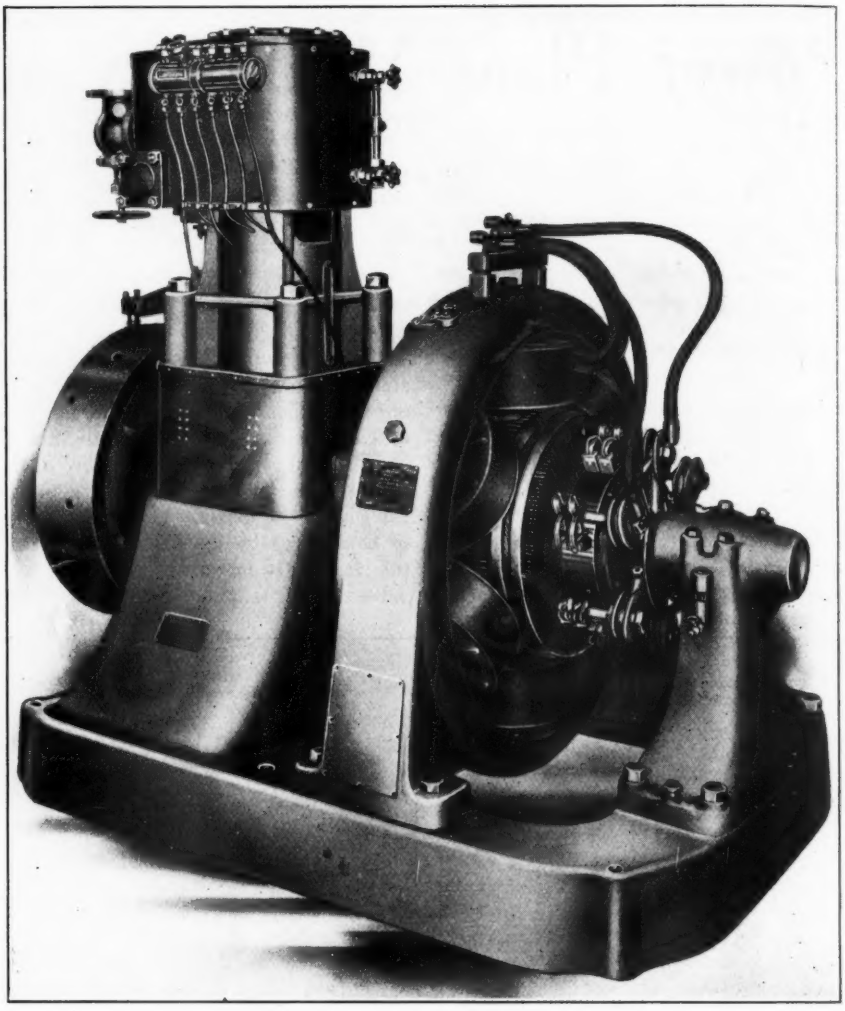


FIG. 1. GENERAL ELECTRIC DIRECT-CONNECTED OUTFIT

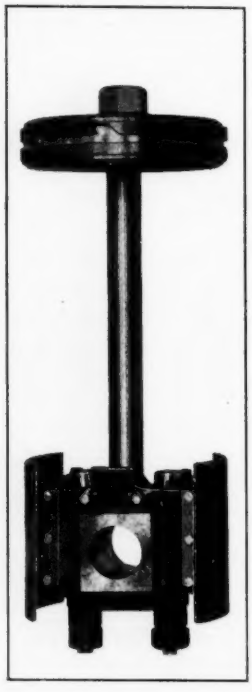


FIG. 3

FIG. 4

FIG. 5

FIG. 6

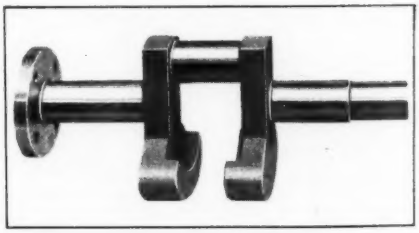


FIG. 2. CRANK SHAFT

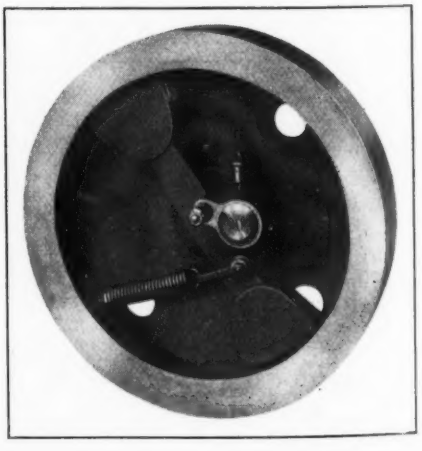


FIG. 7. THE GOVERNOR

high speed and hard service. The crank shaft is forged from open-hearth machine steel and coupled to the dynamo shaft by a flange coupling. Fig. 2 illustrates the construction. Fig. 3 shows the piston, piston rod and crosshead and Fig. 4 the connecting rod. The piston rod and crosshead block are forged in one piece, and phosphor-bronze shoes are bolted to the crosshead. The piston is of solid cast iron fitted with the ordinary cast-iron spring rings. The connecting rod is also of forged steel, with a cast-steel babbitt-lined box at the crank end and a hardened-steel wristpin at the crosshead end, which is forked, as shown, to straddle the crosshead block. The latter is equipped with an adjustable phosphor-bronze box.

The piston valves of the engines of the four-kilowatt and smaller units are of the two-piston balanced type, as indicated by Fig. 5, and the valves of larger engines are of the type shown by Fig. 6, for double ports. The governor, as Fig. 7 indicates, is of the Rites type and needs no description.

These outfits are built with single-cylinder engines up to 50 kilowatts and with tandem-compound engines in sizes of 25 to 75 kilowatts. The single-cylinder type is built also with special cylinders for low steam pressures.

The Siegrist Tank Valve

A valve which embodies in its construction many valuable points and which is said to overcome the troubles experienced in the use of the ordinary balance valves, butterfly valves, etc., is the Siegrist tank valve, which is operated by the water pressure of the line in which the valve is installed. It is also said to be absolutely positive in its operation regardless of the pressure.

The valve, which is shown in the sectional view, Fig. 1, is built either straight or angle type. The body of the valve is composed of a cast-iron shell. The upper part is composed of a brass shell which is screwed into the body, and bored a smooth finish for the piston *B*, which is composed of the two leather cups B^1 and B^2. Projecting from the washer, which holds the leather cups in place, is a brass piston *C* which slides up and down in the leather cup *A*, which cup is held in place by the brass cage *D*. The piston *C* has a large number of holes in its lower end, the total area of which is greater than the area of the supply pipe.

The operation of the valve is as follows:

The pressure of the supply pipe is on both sides of the piston *B*, Fig. 2. The pressure of the upper side of the piston *B* is furnished from the ¼-inch pipe. The pressure on the under side passes through cage *D* and around the brass piston *C*, Fig. 1. The total pressure on the upper side of the piston *B* is greater than the total pressure on the under side, due to the piston *C*. The result is that the excess pressure on the upper side forces the piston down, so that the holes in the piston *C* are all below leather cup *A*, as shown in Fig. 1. The valve is thus closed tight. The pressure on the top of piston *B* is controlled by a special ball cock *A*, Fig. 2, which is made extra heavy with phosphor-bronze seat and disk.

If the water level drops in the heater or tank the ball float opens the ball cock *A* and the water flowing from the ½-inch pipe reduces the pressure on the upper side of piston *B*. As soon as the drop in pressure on the upper side is sufficient to overcome the loss in the area, due to piston *C*, the piston *B* is forced up until the holes in piston *C* are above the leather cup *A*. Water then flows through the valve in a practically steady stream and the makers guarantee the valve to control within a maximum variation of ¼ of an inch. An outside float chamber for tanks or heaters where a ball float cannot be put inside is shown in Fig. 3.

The leather cups *A*, B^1 and B^2 are the only parts that will wear out in years and

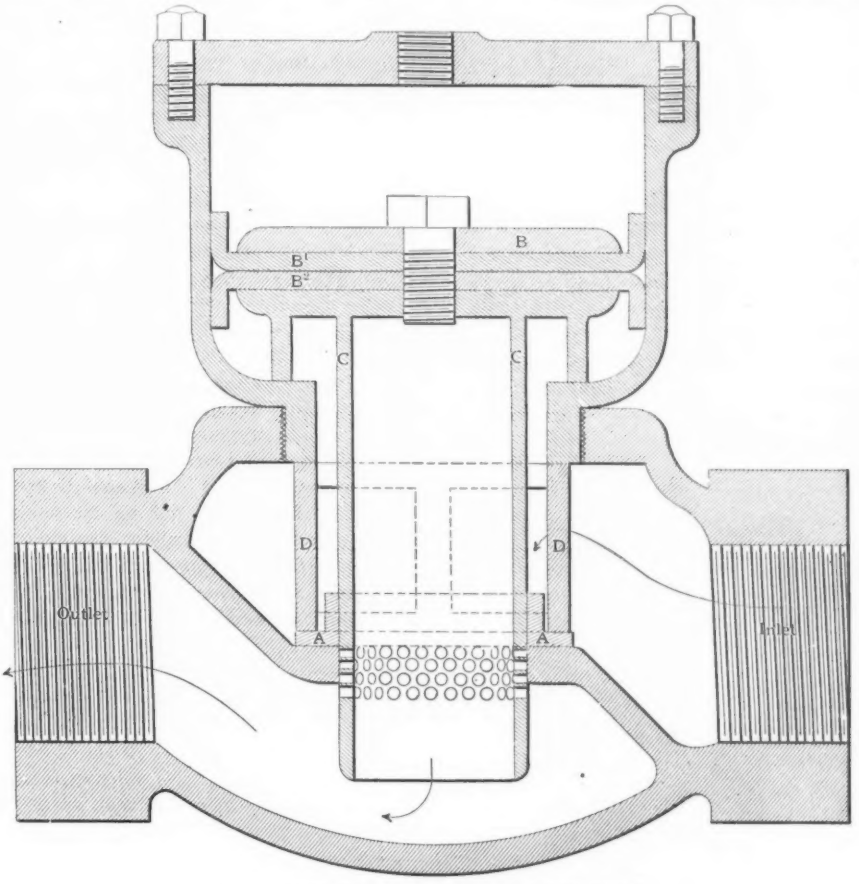


FIG. 1. SECTIONAL VIEW OF SIEGRIST VALVE

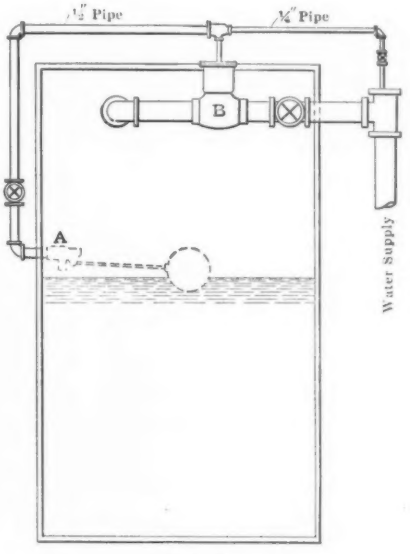


FIG. 2

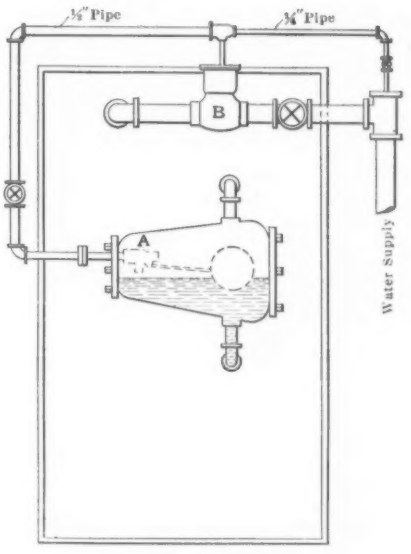


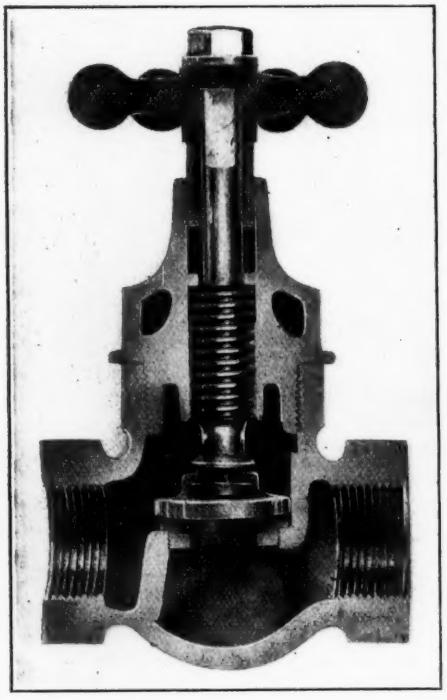
FIG. 3

these can be renewed at a trifling expense and with a minimum amount of labor and without removing the body of the valve from the line. No pressure is said to be too high or too low for the valve to give the best of satisfaction. There is no loss of water or steam in its operation and levers, stuffing boxes, etc., are wholly lacking in this valve.

This valve has been designed by Charles F. Siegrist, chief engineer, Rockefeller building, Cleveland, Ohio.

The "Detroit" Valve

Accompanying is a sectional view of the "Detroit" valve, the body of which is constructed of bronze and which is made in two weights, medium and extra-heavy, the medium being guaranteed for 250 pounds steam pressure and the extra-heavy for 500 pounds. No packing nut



THE DETROIT VALVE

is used to hold the packing in place, which eliminates the possibility of such nut becoming unscrewed by the opening of the valve.

The stem packing is kept in position by a gland, the construction of which permits it to fit closely to the stem hubs so that the packing cannot work out. The valve is fitted with a one-piece removable disk, with no nuts, screws or pins. It can only be removed from the seat by first removing the cap from the valve; therefore, the disk cannot come off the stem when the valve is in use. The one-piece removable seat is so designed that the thrust on the valve stem is carried on a shoulder on the seat, which relieves the thread of the pressure which would otherwise come on it when the valve is closed. This shoulder makes a steam-tight joint, as also does the thread.

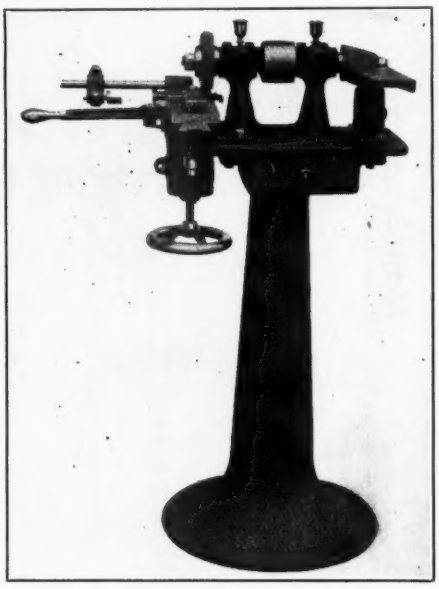
The disk and seat are made heavy to allow for repeated regrinding, or reseating, and can be replaced at a very nominal expense without removing the valve from the pipe line. All that is needed to remove the seat, or to put in a new one, is a flat bar small enough to enter the seat opening and engage the lugs on the inner surface. These features are shown in the illustration. This valve is manufactured by the Detroit Valve and Manufacturing Company, Detroit, Mich.

Reeves Bearing Metal

A new high-grade anti-friction metal for bearings has been brought out by the Reeves Pulley Company, Columbus, Ind., which has been conducting experiments along the line of babbitt metal extending over five or six years. It is said that the metal has been subjected to every conceivable test, with excellent results. It is suitable for line-shafting boxes and all types of bearing where a high-grade babbitt metal is required.

Die Grinding Machine

The die-grinding machine herewith illustrated has a specially formed wheel



DIE-GRINDING MACHINE

on one end of the spindle. The die is clamped to the platen beneath the wheel, and is moved back and forth with a lever, at the same time the wheel is gradually raised by means of a handwheel. The gage on the platen, against which the die is placed, is adjustable at any angle with the wheel, so that straight-thread dies as well as the regular taper dies can be ground. The shape of the wheel gives the die the correct angle of rake. A wheel templet is furnished to assist in dressing the wheel to the correct shape. A dresser is also provided. The cone-shaped wheel on the other end of the spindle is for grinding the lead. By removing the special-shaped wheel and using a straight-face wheel, which is also furnished, the machine may be used for grinding other tools. It is manufactured by the Bignall & Keeler Manufacturing Company, Edwardsville, Ill.

"Belmont" Expansion Packing

We present herewith illustrations showing the three-break joint feature of the "Belmont" expansion packing, manufactured by the Clement Restein Company, Philadelphia, Penn. This packing consists of a casing constructed with rubber back and rubber fibrous sides and holding within its channel two sliding wedges.

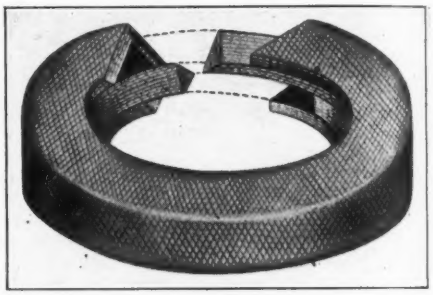


FIG. 1. RING OPEN

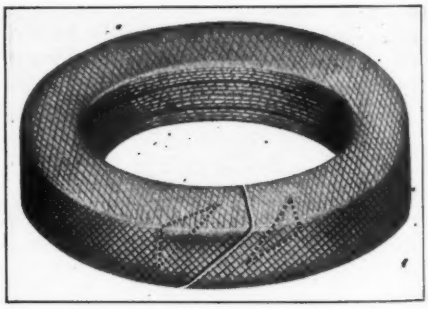


FIG. 2. RING CLOSED

When the ring is to be placed in position the ends of one wedge are drawn ahead of the ends of the casing, and the ends of the other wedge drawn back, so that the relative positions of the six ends are as shown in Fig. 1. When placed in position on the rod the three breaks occur at different points around the circumference of the rod, as shown in Fig. 2. When under gland pressure, the sides of the casing are drawn together and they in turn squeeze the wedges tightly against the wearing surface, making a tight packing.

Book Reviews

THE SLIDE RULE. By C. N. Pickworth. Published by D. Van Nostrand Company, New York, 1908. Price, $1.

This is the eleventh edition of Mr. Pickworth's excellent little manual, and it has been reset in new type throughout and extended somewhat. The chief additions consist of suggestions for solving formulas, extracting cube roots and finding small powers and roots. Some new instruments are described and a few new illustrations added.

NOTES ON HYDROELECTRIC DEVELOPMENTS. By Preston Player. Published by McGraw Publishing Company, New York, 1908. Cloth; 72 pages, 4¾x7¼ inches. Price, $1.

The object of this little book is to present advice and information as to the procedure and methods which should be followed in developing a natural water power into a commercial hydroelectric enterprise. The ideas are very clearly expressed and the advice, in the main, is sound. The punctuation is sometimes a handicap, but never a very serious one. There is an astonishing quantity of information compacted into the space of sixty-five pages of actual text.

HOW TO BUILD UP FURNACE EFFICIENCY. By Joseph W. Hays. Published by the author at 601 Hartford building, Chicago. 48 pages, 3½x6¼ inches; paper covers. Price, 50 cents.

To emphasize the benefits obtained by intelligent attention to the processes of the fire room, to popularize the practice of gas analysis, to point out the significance of the results of such analysis, the apparatus required, its use and limitations, and in general to advise the user of steam boilers how to build up furnace efficiency, are the purposes of this brochure. "The bulk of the losses due to faulty furnace operation are chargeable to excess air. Don't flatter yourself because your stack is clear that you are operating your furnace economically. You may be passing a thousand per cent. excess atmosphere through your furnace and across the heating surface of your boiler. Instead of a power plant, you may be running a hot-air factory. Beef and bone can heave coal, but it takes brains to make a good furnace operative. False ideas of economy have led us to establish a scale of wages for the fireman that cannot look good to the man with brains enough to grasp and solve furnace-room problems."

The author regards the proper use of the CO_2 recording apparatus to be to check the performance of a plant and keep the furnace efficiency high, but it does not tell how to increase the efficiency. Hand instruments and automatic sampling vessels meet the situation squarely. Such questions as: "Does low CO_2 at breeching express waste or economy?" "What draft is consistent with the most economical operation of your plant?" "Should the draft be regulated by the damper or ashpit doors?" "Are the fires too thick or too thin?" "Should the coal be fired wet or dry?" and many others are discussed.

STEAM PLANT ENGINEERING. By Prof. G. F. Gebhardt. John Wiley & Sons, New York, 1908. Cloth; 816 pages, 6x9 inches, illustrated. Price, $6.

This book is a presentation, in concrete form, of the substance of the lectures delivered to his classes by the author, who is professor of mechanical engineering at the Armour Institute of Technology. Designed primarily as a textbook for engineering students, it is expected to be also of use to practicing engineers. Such a book naturally begins with the definitions of the terminology of its subject, but it seems hardly necessary to take space and time to say that when the power is used for pumping water it (the plant) is called a "pumping station" (which term is equally applicable, by the way, to stations pumping gas and oil), or that a compressed-air plant is one that is used for compressing air. Descriptions are given of elementary steam-power plants, with diagrams illustrating the arrangement of the various parts all plainly marked with their ordinary names, for noncondensing plant, with and without an attached heating system, and condensing plant with and without a full complement of heat-saving appliances, each with a table showing the distribution of heat units and the percentage which may be expected to be usefully applied.

Chapter II treats of Fuels and Combustion, classifying and defining the fuels available, giving their reactions in combustion with the temperature produced, air required, etc., with tables of the heat carried away at different uptake temperatures, losses due to incomplete combustion, etc. The influence of size of coal on boiler capacity and efficiency is illustrated by a diagram. Several types of burner for pulverized fuel and oil are illustrated, but none for gas. The third chapter, devoted to Boilers, illustrates and describes the usual types in common use, explains the unit of evaporation, heating surface, boiler and furnace efficiency, etc. In his remarks upon the effect of capacity on efficiency, the author does not comment upon the recently reported performances, where greatly increased evaporations have been attained per square foot of heating surface at small sacrifice of efficiency, nor upon the work along this line of Professor Perry abroad, or Messrs. Ray, Kreisinger and Weeks of our own Geological Survey.

Chapter IV treats of Smoke Prevention, Furnaces and Stokers, and in Chapter V the available information upon Superheat is grouped into the most convenient form that we have yet seen it for the practical man. Coal and Ash Handling Apparatus are then taken up. The succeeding two chapters, upon Chimneys and Mechanical Draft, contain that of which the practicing engineer is most likely to have need presented in a form available for ready use.

Steam Engines and Steam Turbines are then taken up. It is the author's opinion that notwithstanding the encroachments of the turbine and the gas engines, "the reciprocating steam engine will hold its own for years to come." The engine chapter is devoted to a general consideration of the effects of various disturbing causes upon the ideal engine, the value of condensing, compounding, reheating, jacketing performances under test, etc., without any attempt to describe existing types. That on the Turbine, however, consists in large part of descriptions of the forms most used, although much general information on cost, effects of pressure, vacuum, superheat, etc., is included. The chapter upon Condensers covers 65 pages and includes water towers, cooling ponds, dry-air and evaporative condensers. There are 50 pages upon Feed Water Purifiers and Heaters. The chapter upon Pumps includes a treatment of the multistage turbine and volute pumps, and even the air lift. Separators, Traps and Drains have a chapter to themselves. One of the longest chapters in the book is devoted to Pipes and Fittings. Lubricants and Lubrication, Furnace and Economics, Cost of Power, Testing and Measuring Apparatus, Typical Specifications and descriptions of A Typical Central Station and A Typical Isolated Plant complete the body of the work, a General Bibliography of the subject, the A. S. M. E. codes of Rules for Conducting Boiler and Engine Tests being introduced as appendices.

A commendable feature of the work is the placing after each section of a list of the sources of information upon the subject of which it treats. The book is made in the Wiley usual excellent style and the illustrations were evidently "made to order." The treatment is such as to make the book serviceable for the man of limited mathematical attainments. It is a book that can be studied to advantage and that having been studied will be much used for reference.

Books Received

"Wireless Telegraphy and Telephony," By Walter W. Massie and Charles R. Underhill. D. Van Nostrand Company, New York. Cloth; 76 pages, 5x7½ inches; 28 illustrations; indexed. Price, $1.

"Modern Power Gas Producer Practice and Applications." By Horace Allen. The Technical Publishing Company, Ltd., London, W. C. Cloth; 326 pages, 4½x7½ inches; 112 illustrations; indexed. Price, six shillings.

The fourth annual entertainment and reception of the Universal Craftsmen Council of Engineers of the metropolitan district was held at Lexington Opera House, New York, Friday evening, October 23. The large hall, which was most tastefully decorated, was comfortably filled, among those present being many persons prominent in engineering circles. A good vaudeville performance was followed by dancing. During the entertainment, William Armstrong, an earnest worker of the organization, was presented a handsome umbrella. The event was a decided social and financial success and the several committees are to be congratulated.

Business Items

Recent sales made by the Ohio Blower Company, of Cleveland, include 23 "Swartwout" cast-iron exhaust heads ranging in size from 6 to 14 inches, and 11 "Swartwout" steam separators.

The Nebraska Corn Products Company, of Beatrice, Neb., recently placed an order with the Minneapolis Steel and Machinery Company for a 16x36 heavy-duty Twin City Corliss engine for the new plant which it is building.

The Marine Boiler Works Company, Toledo, O., has been using a Buckeye boiler skimmer in the boiler in its power plant for some time and writes the Buckeye Boiler Skimmer Company, South End, Toledo, O., that the skimmer is doing more than was expected, not only keeping the boiler clean, but causing the old scale to fall off.

Neemes Brothers, 41 Adams street, Troy, N. Y., makers of improved clinker-cutting, shaking and dumping grates, report orders for 67 sets of large sizes during September and the first three weeks of October. These orders called for grates ranging in size from 5 feet long by 5 feet wide to 12 feet long by 12 feet 6 inches wide. Besides the above there were a number of orders received for the smaller sizes.

The United Cigarette Machine Company, of Lynchburg, Va., which has used several Foos engines in its power plant for eight or ten years, recently placed an order with the Foos Gas Engine Company, of Springfield, O., for one 100-horsepower multiple-cylinder vertical engine and producer-gas plant, complete. This engine will be direct-connected to a General Electric dynamo, to supply current for the operation of the new plant, which is nearing completion.

The American Compressor and Pump Company has been organized for the manufacture of air and gas compressors, air receivers, high-duty vacuum pumps, pneumatic specialties, etc. The works, located at 718 East Pratt street, Baltimore, Md., are in charge of Alexander Slaysman, Jr., of the firm of Slaysman & Company, engineers, machinists and manufacturers of automatic can-making machinery, etc. Having a fully organized shop, equipped with improved tools, the company is prepared to make prompt shipments. The sales department is in charge of Frederick B. Vail, who has just severed his connection as general sales agent of the American Air Compressor Works, with which Mr. Vail had been connected since its organization. Previous to this he was manager of the Clayton Air Compressor Works. The new company can, therefore, furnish all repairs for either of these makes promptly.

New Equipment

The Radford (Va.) Ice Company will rebuild ice plant recently burned.

An addition is being built to the municipal electric-light plant at New Prague, Minn.

The city of Muskogee, Okla., has voted $250,000 bonds for extending water works.

The city of Merkel, Texas, has voted to issue bonds for the construction of water works.

The city of Ennis, Texas, has voted to issue $13,000 bonds for constructing water works.

The city of South Haven, Mich., is figuring on doubling its 250-horsepower producer plant.

The city council, Montpelier, Vt., is said to have decided to install pumps at Upper Berlin pond.

The Fort Wayne (Ind.) and Wabash Valley Traction Company will erect a substation in Ossian, Ind.

The city of Amory, Miss., is considering the question of constructing water works and sewer system.

The city council of Baldwin, Kan., is said to be considering the question of constructing water works.

The city of Seattle, Wash., has appropriated $430,000 for improving the municipal electric-light plant.

The citizens of East Lansing, Mich., voted to issue $10,000 bonds for constructing water, sewer and drainage systems.

The City Hospital at Louisville, Ky., will soon be in the market for a new engine. Bids have not yet been asked for.

The city council, Norfolk, Va., has under consideration the question of establishing a municipal electric-light plant.

The citizens of Belgrade, Neb., are considering the question of establishing an electric-light plant and water works.

The city of Marion, N. C., has voted to issue $20,000 bonds for a gravity water supply system. J. H. Rider, engineer in charge.

The Virginia (Minn.) Light and Water Company will put up a new power house in which will be installed a steam plant.

The Acme Portland Cement Company, Spokane, Wash., is planning to erect a plant to cost over $600,000. Electric power will be used.

It is reported that specifications are being prepared for new pumping machinery for the water-works plant at Traverse City, Mich.

The Roosevelt (L. I., N. Y.), Water, Light and Power Company has been incorporated with $50,000 capital and is seeking franchise.

It is reported that the New York & Queens County Railway Company will erect new car house, shops and power station at Newtown, S. D

F. Largen, Floresville, Fla., is said to have been granted a franchise by the city council to construct and operate an electric-light plant.

The citizens of Winchendon, Mass., voted to authorize the Board of Water Commissioners to purchase another pump for the pumping station

The Temple (Texas) Light and Power Company is being organized to establish a light and power plant. William Ginnuth is interested.

Plans are being made to install an additional 250-horsepower engine and generator in the municipal electric-light plant at Humboldt, Tenn.

Plans are being prepared for installing a central electric-lighting plant at Yale University, New Haven, Conn., at a cost of about $50,000.

The Edmonds (Wash.) Electric Light and Power Company has secured site for its proposed plant. A 200-horsepower steam plant will be installed.

The Water Commissioners, Erie, Penn., are said to be preparing plans and specifications for a 20,000,000 gallon vertical triple-expansion self contained pumping engine.

The Pittsburg & East Liverpool Railway Company has been formed to construct a railroad from Pittsburg to East Liverpool, Ohio. J. M. Reed, Dravosburg, Penn., is president.

The citizens of Winterset, Iowa, voted to issue $60,000 for the construction of water works. W. K. Palmer Engineering Company, Kansas City, Mo., engineers.

The Lewisburg (Tenn.) Light and Power Company is said to have purchased the municipal light plant of Lewisburg and will improve same. The company might also install an ice plant.

New Catalogs

Weber Gas Engine Company, Kansas City, Mo. Brochure No. 58. Gas engines and producers. Illustrated, 4x8½ inches.

The Ruemmeli-Dawley Manufacturing Company, St. Louis, Mo. Catalog. Water cooling towers. Illustrated, 6x9 inches.

The Carlyle Johnson Machine Company, Hartford, Conn. Catalog. Johnson friction clutch. Illustrated, 36 pages, 4½x7 inches.

Pittsburgh Gage and Supply Company, Pittsburg, Penn. Catalog. Pittsburg steam and oil separators. Illustrated, 12 pages, 6x9 inches.

The Walsh & Weidner Boiler Company, Chattanooga, Tenn. Catalog. Grate bars, shaking grates, boiler tube scraper, boilers, etc. Illustrated, 6x9 inches.

The Triumph Ice Machine Company, Cincinnati, Ohio. Bulletin No. 501. Dealing with the Proper Construction of a Compressor. Illustrated, 32 pages, 6x9 inches.

American Spiral Pipe Works, Chicago, Ill. Catalog No. 5. Spiral riveted pipe, forged steel pipe connections, exhaust steam and hydraulic supplies. Illustrated. 78 pages, 8x10½ inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high grade goods. Address "M. M. Co.," POWER.

ENGINEERS wanted to sell the Simplex pipe clamp for stopping leaky pipe joints and the Simplex blow-off valve for boilers in evenings among their fellow engineers on a large commission. Write! The Simplex Engineering Co., 316 Preston St., Phila., Pa.

WANTED—Mechanical draftsman, young man familiar with high-speed engines; excellent opportunity for the right party to work into leading position. To receive consideration give full details of experience, length of engagements, salary received, etc., etc. Box 53, POWER.

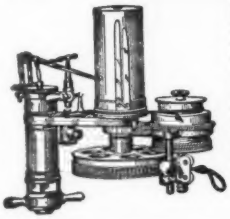
WANTED—Salesmen, capable men, to sell a wonderful fuel and labor saving device for boilers. Sells for $50.00. 20,000 in use in United States and Canada. Splendid testimonials. We offer liberal contract. Fine opportunity for a hustler. "Diamond" Power Specialty Co., 236 Fort St., West, Detroit, Mich.

WANTED—Engineer salesman, with both technical education and practical experience in machine tools, steam engines, boilers, gas engines, pumps, etc. Specialists in any of these lines would be considered, but prefer-

KEEP QUIET

That's what New Process Rawhide Gears and Pinions do. They also save oil, save the gears and pinions they m sh with and guarantee the *best results*, with none of the noise and racket common to metal gearing. *Catalog?*

THE NEW PROCESS RAW HIDE COMPANY,
SYRACUSE, NEW YORK.



WHAT! NO INDICATOR?

Don't you know that I can give you a fine up-to-date outfit, new, from $25 00 up, and that I will let you p.y a part of it acting as my agent in your s, are t me?

I will give you a thorough course of indicator instruction with a fine indicator to practice with for $5 00 per mo. Catalog?

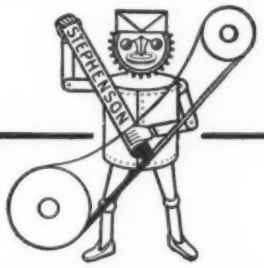
Extra ¼ in. Area Cyl for Ammonia, Gas Engine and high pressure work.

A. C. LIPPINCOTT, Newark, N. J.

THE BRISTOL COMPANY
MANUFACTURERS OF
BRISTOL'S RECORDING PRESSURE
AND
VACUUM GAUGES
AND

a complete line of recording instruments for pressure, temperature and electricity.

THE BRISTOL COMPANY
Waterbury, Conn.
Branch Offices: NEW YORK, CHICAGO



THE AFTER EFFECTS ARE PLEASANT

Don't waste good belts and lose valuable power. **STEPHENSON Bar Belt Dressings** contain no Rosin nor any other ingredients injurious to Belting. Our **RED Label** and **GREEN Label Brands** are two entirely different and distinct preparations. No **one** kind of Dressing is good for **all** Belts—you know that. **STEPHENSON Dressing** not only prevents slipping and gives full speed from slack belts, but **the after effects are pleasant**—it KEEPS those belts in good condition and greatly prolongs their life.

This means a saving in BELTING, which is an important item when figuring the year's expenses.

RED Label Brand for Leather belts;
GREEN Label for Rubber and Canvas.

Your protection against substitution is **The Man with the Cog-Wheel Face** on each Pound Stick.

Of Dealers everywhere, or

STEPHENSON MFG. CO.
ALBANY, N. Y

HARBISON-WALKER REFRACTORIES CO.

PITTSBURGH, PA.

Makers
Highest Grade Refractories
Importers
Chrome Ore
Sole Agents
Carl Spaeter Magnesite

Fire Clay, Silica, Magnesia, Chrome
BRICK

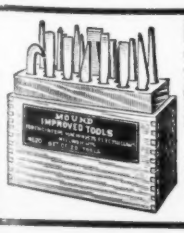
Bricks and Shapes for Setting all makes of Boilers and Stokers.
Hundreds of Installations
Longest Service
Greatest Economy

7,500 Regular Customers
Write for Booklet P
1,200,000 Daily Capacity

Tamper-Proof
The Mason Reducing Valve

Because the key that locks it at any desired pressure slips into the engineer's pocket. The "Mason" permanently maintains an absolutely uniform reduced pressure. Catalog?

The Mason Regulator Company, Boston, Mass.



MOUND TOOLS. FOR THE ENGINE ROOM;

This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.

No. 20 Set of 20 Tools . . . $4.00.

Book "Engineers' Chums" free. Address Dept. B

MOUND TOOL AND SCRAPER CO.
1606-1608 N. BROADWAY, ST. LOUIS, U. S. A.

FOR SALE BY ALL SUPPLY HOUSES

50 CTS. PER STICK, $5.00 PER DOZEN

It is the only article that will prevent sparking. Will keep the Commutator in good condition and prevent cutting. Absolutely will not gum the brushes.

It will put that high gloss on the Commutator you have so long sought.

K. McLennan & Co., Sole Manufacturers
411-130 Dearborn St., Chicago, Ill.

ence given to the greatest experience and ability. State age, experience and salary. To party "making good," opportunity would be afforded, if desired, to engage capital with services. Established business, growing fast. Address "Pacific Coast," care POWER.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AS ENGINEER in country water works, any locality, by man having seventeen years' engineering experience in Chicago. Box 55, POWER.

DRAFTSMAN having fourteen years experience with gas engines and producers, desires to meet firm wishing to manufacture same. Box 56, POWER.

CHIEF ENGINEER, twenty years' experience; seven years with last employer large manufacturing plant, desires position; best of references. "C. M.," POWER.

CHIEF ENGINEER of large industrial plant desires change; active and alive, an expert with indicators and testing apparatus, can keep operating expenses at proper figures. Box 27, POWER.

AN EDUCATED, well dressed young man, twenty-five, wants position as salesman with reliable firm; understands power plant thoroughly; best of references. Box 54, POWER.

POSITION WANTED as chief engineer; experienced with all kinds of engines, steam turbines, a.c. and d.c. generators, motors and switchboards, boilers and pumps; I can get results and furnish the references; have been seventeen years in the mechanical and engineering business. Box 9, POWER.

WANTED—Position with some company that is planning or installing a producer gas engine. I am willing to start at the foundation and work up; have had experience with both two- and four-cycle engines; been with present employer three years in an electric-light plant; can give references. D. D. Rutledge, Alma, Kan.

WANTED—Position as advertising manager. Have had years of experience in building catalogs booklets, folders, etc.; also have a practical knowledge of printing values and all details in connection therewith. I hold similar position at the present time, but for good reasons desire a change. Address A. R. M., 1457 Wilson Avenue, Chicago, Ill.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

IF YOU DESIRE to learn the latest improvements in steam boilers, correspond with the Detroit Water Tube Boiler Co., Detroit.

BOILER TUBES CRACKING? Can stop or no pay; any boiler. Wm. Fulton Engineering Co., Office, 28 N. Canal St., Dayton, O.

ENGINES AND BOILERS, ⅛ to 2 h.p., engine castings in sets. Models and general machine work. Sipp Electric and Machine Co., Paterson, N. J. Catalog 4c.

PATENTS—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make an investigation and report if patent can be had, and exact cost.

INDICATOR CARDS worked out, $1 each. Strictly confidential; any questions answered; r.p.m., spring No., engine size, make, etc., required. Jos. J. Hosler, M. E., Eagle Blk., Canton, O.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner, U. S. Patent Office, McGill Bldg., Washington, D. C.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

ENGINEERS, firemen, electricians, machinists, etc. New 25-page pamphlet containing questions asked by the examining boards sent free upon request. Geo. A. Zeller Book Co., 4468 W. Belle Place, St. Louis, Mo. Established 1870.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Rights in a valuable invention. Variable speed changes for lathes, planes, drills, shapers, etc.; economical and efficient. Address William Wallace White, 309 Broadway, New York.

ONE 23x60 SINGLE-CYLINDER, double-acting Harris Corliss. Pendulum ball governor with sectional cast-iron flywheel, 18 feet by 38 inches; good order, requirements changed, electric power being used. Almond Mfg. Co., Ashburnham, Mass.

Alphabetical Index to Advertisers

	PAGE
Ajax Iron Works	155
Alberger Co., A. H	155
Alberger Condenser Co	144
Allan & Son, A	155
American & British Mfg. Co	161
American Boiler Economy Co	149
American Diesel Engine Co	154
American District Steam Co	127
American Engine Co	160
American Goetze-Gasket & Packing Co	95
American Huhn Metallic Packing Co	110
American Injector Co	133
American Mfg. Co	81
American Pulley Co	125
American School of Correspondence	97 and 119
American Steam Gauge & Valve Mfg. Co	83
American Steam Packing Co	110
Anchor Packing Co	110
Anderson Co., V. D	100
Armstrong Mfg Co	135
Ashton Valve Co	118
Audel & Co., Theo	93
Austin Separator Co	95
Automatic Safety Water Gauge Co	116
Babcock & Wilcox Co	148
Ball-Cooley Engineering Co	155
Ball Engine Co	161
Ball & Wood Co	116
Baragwanath & Son, Wm	142
Bard Union Co	115
Barnes Co., W. F. & John	93
Bartlett & Snow Co., C. O	138
Bass Fdry. & Machine Co	157
Beggs & Co., James	96
Berry Engineering Co	148
Bigelow Co	146
Bignall & Keeler Mfg. Co	117
Binghamton Boiler Compound Co	127
Bird-Archer Co	127
Blake Pump & Condenser Co	144
Bowers Rubber Works	101
Brandt, Randolph	110
Bristol Co	77
Broomell, Schmidt & Steacy Co	153
Bruce-Meriam-Abbott Co	152
Buckeye Boiler Skimmer Co	128
Buckeye Engine Co	158
Buffalo Forge Co	139
Bulkley, Henry W	144
Burt Mfg. Co	10
C & C Electric Co	152
Carey Co., Philip	120
Carpenter & Co., Walter D	129
Chaplin-Fulton Mfg. Co	148
Chapman Valve Mfg. Co	115
Chesterton Co., A. W	101
Chuse Engine & Mfg Co	156
Clark Bros. Co	159
Cleveland Belting & Machinery Co	109
Climax Smoke Preventer Co	138
Cling-Surface Co	126
Continental Natural Gas Alcohol Co	91
Cook's Sons, Adam	130
Cooper Co., C. & G	157
C-O-Two Furnace Co	139
Crosby Steam Gage & Valve Co	118
Crowe, Paul L	91
Cruise & Co	151
Curtis & Curtis Co	117
Dart Mfg. Co., E. M	118
Davis Co., John	149
Davis Regulator Co., G. M	149
Davis, William M	132
Dean Bros. Steam Pump Works	143
Dearborn Drug & Chemical Works	5
De Laval Steam Turbine Co	143
De La Vergne Machine Co	155
Deming Co	144
d'Este Co., Julian	100
Detroit Leather Specialty Co	109
Detroit Lubricator Co	131
Detroit Stoker & Fdry. Co	135
Diamond Rubber Co	108
Direct Separator Co	96
Dixon Crucible Co., Joseph	129
Du Bois Iron Wks	154
Dunham Co., C. A	97
Eastwood Wire Mfg. Co	113
Eclipse Feed Water Heater and Purifier Co	141
Engberg's Electric and Mechanical Works	152
Epping-Carpenter Co	144
Erie Mfg. & Supply Co	159
Eureka Packing Co	105
Fidelity & Casualty Co	150
Fisher Governor Co	148
Fishkill Landing Mach Co	156
Fitchburg Steam Engine Co	156
Flinn, Richard J	97
Flower Steam Specialty Co., Walter L	131
Foos Gas Engine Co	153
Franklin Boiler Works Co	146
Gandy Belting Co	127
Gardner Governor & Separator Co	96
Garlock Packing Co	1
Gas Machinery Co	153
General Electric Co	152
Golden-Anderson Valve Specialty Co	115
Goulds Mfg. Co	143
Green Engineering Co	135
Green Fuel Economizer Co	140
Greene, Tweed & Co	107 and 131
Griffith & Wedge Co	157
Griscom-Spencer Co	140
Hammel Oil Burner Co	130
Harbison-Walker Refractories Co	77
Harris Oil Co., A. W	132
Harris Steam Engine Co., Wm. A	158
Harrisburg Fdry. & Machine Works	158
Harrison Safety Boiler Wks	89
Hawkeye Compound Co	128
Heine Safety Boiler Co	145
Hercules Float Works	117
Hercules Pulley Cover Co	125
Hershey Mach. & Fdry. Co	96
Hewes & Phillips Iron Works	159
Hill Publishing Co., 91, 92, 110 and	134
Hoffman, Geo. W	140
Home Rubber Co	103
Homestead Valve Mfg. Co	113
Hoppes Mfg. Co	141
Houchin-Aiken Co	110
Houghton & Co., E. F	99
Hussey, McCann & Co	97
Huyette Co., Paul B	116
International Correspondence Schools	91
Jefferson Union Co	115
Jeffrey Mfg. Co	125
Jerguson Mfg. Co	116
Johns-Manville Co., H. W	119
Johnson Co., Henry	110
Keasbey, Robt. A	115
Keeler Co., E	145
Kellogg & Co., E. H	129
Kennedy Valve Mfg. Co	115
Kerr Turbine Co	154
Kewanee Boiler Co	151
Keyes & Son, F. E	142
Keystone Lubricating Co	3 and 163
Kunkle & Co., E. B	113
Lagonda Mfg. Co	121
Lammert & Mann	156
Leavitt Machine Co	118
Liberty Mfg Co	147
Lippincott S. S. & S. Co	77
Loew Mfg. Co	117
Lord Co., Geo. W	87
Ludlow Valve Mfg. Co	114
Lunkenheimer Co	9
McClave-Brooks Co	7
McCrea & Co., James	118
McIntosh, Seymour & Co	157
McLennan & Co., K	77
McLeod & Henry Co	135
Manzel Bros. Co	132
Martin Grate Co	136
Mason Regulator Co	77
Mathews, Hugh	156
Mayville Specialty Mfg Co	138
Mechanical Rubber Co	107
Mercer Rubber Co	108
Mesta Machine Co	156
Michigan Lubricator Co	128
Miller Improved Gas Engine Co	153
Minneapolis Steel and Machinery Co	162
Monarch Steam Blower Co., 110 and	122
Moore & Co., Chas. C	148
Morehead Mfg. Co	100
Morrin Climax Boiler Co	146
Morris Machine Works	144
Morse, R. F	118
Mound Tool and Scraper Co	77
Murphy Iron Works	136
Murray Automatic Boiler Feed Co	148
Murray Iron Works Co	164
Myers & Bro., F. E	144
Nason Mfg. Co	97
National India Rubber Co	106
National Pipe Bending Co	139
National Tube Co	115
Neemes Bros	137
Nelson Valve Co	111
New Bedford Boiler & Mach. Co	113
New Process Rawhide Co	77
New York & New Jersey Lubricant Co	131
New York Belting and Packing Co., Ltd	104
New York Leather Belting Co	124
Northern Electrical Mfg. Co	152
Nugent & Co., Wm. W	132
Ohio Blower Co	94
Ohio Brass Co	113
Ohio Injector Co	133
Otto Gas Engine Works	153
Parker Boiler Co	144
Patterson & Co., F. L	142
Peerless Rubber Mfg. Co	102
Penberthy Injector Co	8
Pennsylvania Flexible Metallic Tubing Co	93
Philips Pressed Steel Pulley Works	122
Pierce Co., Wm. B	2
Pittsburgh Gage & Supply Co	130
Pittsburgh Valve & Fittings Co	114
Pittsburgh Valve, Foundry & Construction Co	112
Platt & Co., John	97
Power & Mining Machinery Co	153
Power Specialty Co	144
Prescott Steam Pump Co., Fred M	143
Providence Engineering Works	158
Quaker City Rubber Co	4
Randle Machinery Co	156
Rathbun-Jones Engineering Co	135
Reeves Pulley Co	112

DUXBAK BELTING

Tests and Testimonials

ERNEST C. MOORE,
Civil Engineer,
Tribune Building, N. Y.

October 14th, 1908.

CHARLES A. SCHIEREN CO.,
39 Ferry Street, N. Y. C.

Gentlemen:—

Replying to your inquiry as to your Duxbak Leather Belts, beg to say that I replaced several rubber belts in the Power House at Tompkins Place & Degraw Street, for the construction of the Gowanus Flushing Tunnel, with your Duxbak Leather Belts as follows:

August	13th, 1907	24"	Belt	56 ft. long.
"	30th, "	26"	"	59 ft. "
Sept	26th, "	20"	"	59 ft. "
March	14th, "	5"	Short	Belt.

These belts have all been running where there was considerable water and also considerable grease, and they have given entire satisfaction

Yours truly,
E. C. MOORE.

JUGHARDT'S CUSTOM LAUNDRY,
Est. 1885,
W. G. JUGHARDT,
394, 396 and 398 Myrtle Ave.,

BROOKLYN, Oct. 16, 1908.

CHAS. A. SCHIEREN COMPANY,
39 Ferry St., New York.

Gentlemen:—

I have used your belting for several years and since you introduced your Duxbak waterproof belt I have bought several for work on Extractors and Washers with very satisfactory results.

My main belt is also a Duxbak Waterproof belt and is in operation where the belt is in contact with oil as well as dampness.

I am glad to testify to the merits of your Duxbak belting, and remain,

Yours truly,
(Signed) W. G. JUGHARDT.

GENERAL STORAGE BATTERY COMPANY

BOONTON, N. J., Oct. 7th, 1908.

Subject: Belting
File No.: S18
THE CHAS. A. SCHIEREN CO.,
39 Ferry St., New York.

Gentlemen:—

Concerning the inquiry for our 22" double perforated "Duxbak" leather belting which you supplied us in Nov., 1906, in the flume house over the tail race. It has given us no trouble of any sort. There is no noticeable slippage on the pulley, although the room is very damp due to the sweating of the flume and more or less water around on account of the location over the tail race. We do not experience any noticeable difficulty due to the moisture.

Yours truly,
GENERAL STORAGE BATTERY CO.,
Per J. Lansing,
M.E. in charge of factories.

JL/EV

"Duxbak" Belting is sold with a return-your-money guarantee that protects the buyer against defects in leather or workmanship and damage by water.

Chas. A. Schieren Company
ESTABLISHED 1868

Tanners,
Belt Manufacturers.
69 Cliff Street, New York.

Chicago, 84-86-88 Franklin St. Pittsburg, 240 Third Ave. Boston, 186-188 Lincoln St. Denver, 1622 Wazee St. Philadelphia, 226 North Third St. Brooklyn, N. Y., 13 h St. and 3rd Ave. Hamburg, Germany, Auf dem Sande 1.
OAK LEATHER TANNERIES, Bristol, Tenn.

	PAGE
Reliable Water Gauge Co	115
Reliance Gauge Column Co	100
Restein Co., Clement	109
Rhoads & Sons J E	123
Ridgway Dynamo & Engine Co	160
Riverside Engine Co	157
Robb-Mumford Boiler Co	145
Robertson & Sons, Jas L	105
Robins New Conveyor Co	126
Rollins Engine Co	154
Rust Boiler Co	146
St John, G C	91
St Louis Iron & Mach Works	159
Salamander Grate Bar Co	136
Sawyer Belting Co	125
Scaife & Sons Co., Wm. B	127
Schaeffer & Budenberg Mfg. Co	133
Schieren Co., Chas. A	79
Schuchardt & Schutte	119
Schutte & Koerting Co	112
Scully Steel & Iron Co	122
Shepherd Engineering Co	160
Sherwood Mfg Co	133
Shultz Belting Co	126
Sight Feed Oil Pump Co	132
Simplex Engineering Co	118
Sirocco Engineering Co	139
Skinner Engine Co	157
Smooth-On Mfg Co	6
Star Brass Mfg. Co	132
Starrett Co., L. S	129
Steel Mill Packing Co	110
Stephenson Mfg Co	77
Sterling Blower & Pipe Mfg. Co	132
Sterling Lubricator Co	132
Stewart Heater Co	140
Stocker, Geo. J	142
Strong, Carlisle & Hammond Co	98
Struthers-Wells Co	154
Sturtevant Co., B. F	151
System Co	122
Thacher & Co., Geo. H	138
Toledo Pipe Threading Mach. Co	117
Trill Indicator Co	93
Trimont Mfg Co	153
Triumph Electric Co	151
Tudor Boiler Mfg. Co	146
Underwood & Co., H. B	155
Union Steam Pump Co	143
Vilter Mfg Co	156
Vogt Machine Co., Henry	146
Walch & Wyeth	115
Walton Co., F S	125
Warren Steam Pump Co	143
Watertown Engine Co	155
Watson & McDaniel Co	148
Webster & Co., Warren	85
Westinghouse Elec. & Mfg. Co	150
Wheeler Condenser & Eng. Co	142
Whitlock Coil Pipe Co	141
Wickes Boiler Co	145
Wickes Bros	93
Wiederholdt Construction Co	138
Wilkinson Mfg. Co	138
Williams & Co., J. H	128
Williams Foundry & Machine Co	93
Williams Valve Co., D. T	96
Wing Mfg. Co., L. J	139
Wright Mfg. Co	101
York Mfg. Co	114

Classified Index to Articles Advertised

Alarms, High and Low Water
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Reliance Gauge Column Co., Cleveland, O.
Wright Mfg. Co., Detroit, Mich.

Alcohol Distillery Apparatus
Continental Natural Gas Alcohol Co., Wheeling, W. Va.

Arch, Back Combustion Chamber
Mayville Specialty Mfg. Co., Mayville, Wis.
McLeod & Henry Co., Troy, N. Y.

Arch, Boiler Door
McLeod & Henry Co., Troy, N. Y.
Mayville Specialty Mfg. Co., Mayville, Wis.

Asbestos Materials
Carey Co., Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

Bars, Cylinder Boring
Mathews, Hugh, Kansas City, Mo.
Underwood & Co., H B., Philadelphia, Pa.

Batteries, Storage
Westinghouse Machine Co., Pittsburg, Pa.

Belt Fasteners
Bristol Co., Waterbury, Conn.

Belt Shifters
Mason Regulator Co., Boston, Mass.

Belting
Anchor Packing Co., Philadelphia, Pa.
Bowers Rubber Works, San Francisco, Cal.
Diamond Rubber Co., Akron, Ohio.
Gandy Belting Co., Baltimore, Md.
Garlock Packing Co., Palmyra, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Johnson Co., Henry, Jersey City N. J.
Laminated Belting Co., New York.
New York Belting & Packing Co., New York.
New York Leather Belting Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robins New Conveyor Co., New York.
Sawyer Belting Co., Cleveland, Ohio.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belting, Leather
New York Leather Belting Co., New York.

Bending, Pipe
Ball & Wood Co., Elizabethport, N. J.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Bends, Wrought Iron Pipe
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Blowers
De Laval Steam Turbine Co., Trenton, N. J.
Green Fuel Economizer Co., Matteawan, N. Y
Ohio Blower Co., Cleveland, O.
Scully Steel & Iron Co., Chicago, Ill.
Sirocco Engineering Co., New York
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Blowers, Steam Jet
McClave-Brooks Co., Scranton, Pa.
Monarch Steam Blower Co., Troy, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.

Boiler Setting
McLeod & Henry Co., Troy, N. Y.

Boiler Tube Protectors
Cruise & Co., Elizabeth, N. J.

Boilers
Babcock & Wilcox Co., New York.
Beggs & Co., James, New York.
Bigelow Co., New Haven, Conn.
Griffith & Wedge Co., Zanesville, Ohio.
Harrisburg Foundry & Mach. Works, Harrisburg, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Minn. Steel and Machinery Co., Minneapolis, Minn.
Morrin Climax Boiler Co., Brooklyn, N. Y.
Murray Iron Works Co., Burlington, Iowa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.
Parker Boiler Co., Philadelphia, Pa.
Robb-Mumford Boiler Co., South Framingham, Mass.
Rust Boiler Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Tudor Boiler Mfg. Co., Cincinnati, O.
Vogt Machine Co., Henry, Louisville, Ky.
Wickes Boiler Co., Saginaw, Mich.
Wickes Bros., Saginaw, Mich.
York Mfg. Co., York, Pa.

Books
American School of Correspondence, Chicago, Ill.
Audel & Co., New York.
Hill Publishing Co., New York.
International Correspondence Schools, Scranton, Pa.
System Co., Chicago, Ill.

Braces, Boiler
Scully Steel & Iron Co., Chicago, Ill.

Brick, Chrome
Harbison-Walker Refractories Co., Pittsburg, Pa.

Brick, Fire
C-O-Two Furnace Co., Syracuse, N. Y.
Harbison-Walker Refractories Co., Pittsburg, Pa.

Brick, Fire Clay
Harbison-Walker Refractories Co., Pittsburg, Pa.
McLeod & Henry Co., Troy, N. Y.

Brick, Magnesia
Harbison-Walker Refractories Co., Pittsburg, Pa.

Brick, Silicia
Harbison-Walker Refractories Co., Pittsburg, Pa.

Calorimeters
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Castings, Brass and Iron
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Salamander Grate Bar Co., New York.

Castings, Steel
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel and Mchy. Co., Minneapolis, Minn.

Cement, Asbestos
Carey Co., Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

Cement, Belt
Rhoads & Sons, J. E., Phila., Pa.

Cement, Boiler
Smooth-On Mfg. Co., Jersey City, N. J.

Cement, Iron
Smooth-On Mfg. Co., Jersey City, N. J.

Cement, Pipe
Johns-Manville Co., H. W., New York.

Cement, Rubber
Peerless Rubber Mfg. Co., New York.

Chambers, Air
Hercules Float Works, Springfield, Mass.

Chimneys
Wiederholdt Construction Co., Chicago, Ill.

Chimneys, Reinforced Concrete
Wiederholdt Construction Co., Chicago, Ill.

Clamp, Pipe
McCrea & Co., James, Chicago, Ill.
Simplex Engineering Co., Philadelphia, Pa.

Cleaners, Mechanical
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Pierce Co., Wm. B., Buffalo, N. Y.
Scully Steel & Iron Co., Chicago, Ill.

Cleaners, Tube
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Chesterton Co., A. W., Boston, Mass.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville Co., H. W., New York.
Lagonda Mfg. Co., Springfield, O.

Cleaners, Tube—*Continued.*
Liberty Mfg. Co., Pittsburg, Pa.
Monarch Steam Blower Co., Troy, N. Y
Pierce Co., Wm. B., Buffalo, N. Y.
Robertson & Sons, Jas. L., New York.
Scully Steel & Iron Co., Chicago, Ill.
Stephenson Mfg. Co., Albany, N. Y.
St. John, G. C., New York.
Stewart Heater Co., Buffalo, N. Y.

Clutches, Coupling
Williams Foundry and Machine Co., Akron, Ohio.

Clutches, Friction
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Reeves Pulley Co., Columbus, Ind.
Williams Foundry & Machine Co., Akron, Ohio.

Cocks, Gage
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., Paul B., Philadelphia, Pa.
Jerguson Mfg. Co., Boston, Mass.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Reliance Gauge Column Co., Cleveland, O.
Schæffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Williams Valve Co., D. T., Cincinnati, Ohio.
Wright Mfg. Co., Detroit, Mich.

Cocks, Steam
Dart Mfg. Co., Providence, R. I.
Homestead Valve Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
National Tube Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

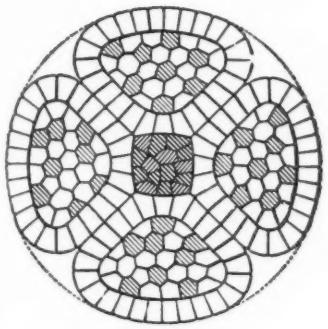
Compound, Boiler
Binghamton Boiler Compound Co., Binghamton, N. Y.
Bird-Archer Co., New York.
Dearborn Drug & Chemical Works, Chicago, Ill.
Harris Oil Co., A. W., Providence, R. I.
Hawk-Eye Compound Co., Chicago, Ill.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
Lord Co., Geo. W., Phila., Pa.
Stephenson Mfg. Co., Albany, N. Y.

Compound, Commutator
Dixon Crucible Co., Jos., Jersey City, N. J.
McLennan & Co., K., Chicago, Ill.

Compound, Lubricating
Cook's Sons, Adam, New York.
Houghton & Co., E. F., Philadelphia, Pa.

Compressors, Air
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Murray Iron Works Co., Burlington, Iowa.
Union Steam Pump Co., Battle Creek, Mich.

"AMERICAN"

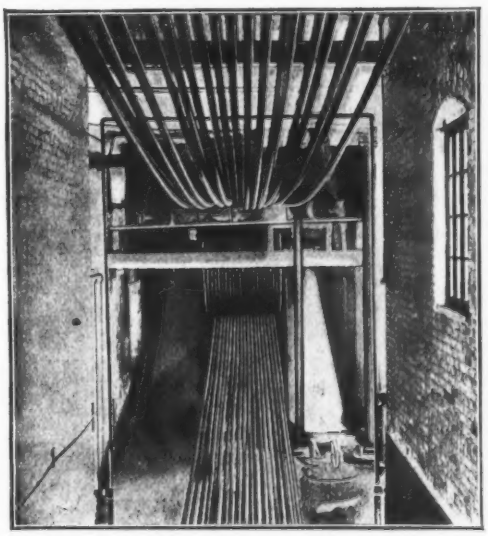


"Like Smooth Rods of Iron"

"American" Transmission Rope in service soon assumes an almost perfectly rounded smooth surface. The graphite lubricant with which the internal yarns and core are saturated, permeates every fibre, facilitating the compression of the strands until the rope becomes smooth and round and presents the greatest area of contact to the sheave groove.

"American" Ropes are designed to turn in their grooves keeping the rope round and smooth and the grooves of the sheaves perfectly true.

If you desire complete information regarding the advantages of rope driving and "American" Transmission Rope, write for a copy of our "Blue Book of Rope Transmission." Copies free.



The American Manufacturing Co.,
65 Wall Street, New York City.

TRANSMISSION ROPE

Condensers

Alberger Condenser Co., New York.
Anderson Co., V. D., Cleveland, O.
Baragwanath & Son, Wm., Chicago, Ill.
Blake Pump and Condenser Co., Fitchburg, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Bulkley, Henry W., Orange, N. J.
Dean Bros. Steam Pump Works, Indianapolis, Ind
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Union Steam Pump Co., Battle Creek, Mich.
Wheeler Condenser and Engineering Co., New York.
Wickes Bros., Saginaw, Mich.

Consumers, Smoke

Griscom-Spencer Co., New York.
Climax Smoke Preventer Co., Boston, Mass.

Controllers, Electric

General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg Co., Pittsburg, Pa.

Controllers, Feed Water

American Boiler Economy Co. Philadelphia, Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.

Cooling Towers

Alberger Condenser Co., New York.
Stocker, Geo. J., St. Louis, Mo.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Correspondence Schools

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Coverings, Pipe and Boiler

Carey Co., Philip, Cincinnati, O.
Houghton & Co., E. F., Philadelphia, Pa.
Johns-Manville Co., H. W., New York.
Keasbey Co., Robt. A., New York

Coverings, Pulley

Houghton & Co., E. F., Philadelphia, Pa.

Cupolas, Foundry

Bigelow Co., New Haven, Conn.

Cylinders, Irrigation

Myers & Bro., F. E., Ashland, O.

Dampers, Blast

Green Fuel Economizer Co., Matteawan, N. Y.

Die Stocks

Curtis & Curtis Co., Bridgeport, Conn

Draft Apparatus

Green Fuel Economizer Co., Matteawan, N. Y.
Sirocco Engineering Co., New York.

Draft, Mechanical

Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Dressing, Belt

Cling-Surface Co., Buffalo, N. Y.
Garlock Packing Co., Palmyra, N. Y.
Harris Oil Co., A. W., Providence, R. I.
Houghton & Co., E. F., Philadelphia, Pa.
Johnson Co., Henry, Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Stephenson Mfg. Co., Albany, N. Y.
Walton Co., F. S., Phila., Pa.

Dressing, Rope

Cling Surface Co., Buffalo, N. Y.

Drills, Upright

Barnes Co., W. F. & John, Rockford, Ill.

Dryers

Bigelow Co., New Haven, Conn.

Dust Collectors

Buffalo Forge Co., Buffalo, N. Y
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.

Dynamos

American Engine Co., Bound Brook, N. J.
C & C Electric Co., New York.
Clark Bros. Co., Belmont, N. Y.
General Elec. Co., Schenectady, N. Y
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, Ohio.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
Wickes Bros., Saginaw, Mich.

Educational

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Ejectors

American Injector Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Electrical Machinery and Supplies

American Engine Co., Bound Brook, N. J.
Bristol Co., Waterbury, Conn.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
General Electric Co., Schenectady, N. Y.
Griscom-Spencer Co., New York.
Johns-Manville Co., H. W., New York.
Ohio Brass Co., Mansfield, O.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
Wickes Bros., Saginaw, Mich.

Elevators and Conveyors

Jeffrey Mfg. Co., Columbus, Ohio.

Engineers, Lubrication

Davis, Wm. M., Boston, Mass.

Engineers, Consulting and Contracting

Moore & Co., Chas. C., San Francisco, Cal.

Engine Stops

Strong, Carlisle & Hammond Co., Cleveland, O.

Engines, Gas and Gasolene

Ajax Iron Works, Corry, Pa.
Alberger Co., A. H., Buffalo, N. Y.
American & British Mfg. Co., Providence, R. I.
Beggs & Co., James, New York.
Bruce-Meriam-Abbott Co., Cleveland, O.
Buckeye Engine Co., Salem, O.
De La Vergne Mach. Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Foos Gas Engine Co., Springfield, Ohio.
Mesta Machine Co., Pittsburg, Pa.
Miller Improved Gas Engine Co., Springfield, O.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Otto Gas Engine Works, Philadelphia, Pa.
Rathbun-Jones Engineering Co., Toledo, Ohio.
Struthers-Wells Co., Warren, Pa.
Westinghouse Mach. Co., Pittsburg, Pa.
Wickes Bros., Saginaw, Mich.

Engines, Oil

American & British Mfg. Co., Providence, R. I.
American Diesel Engine Co., New York.
De La Vergne Mach. Co., New York.
Du Bois Iron Works, Du Bois, Pa.

Engines, Rotary

Ball-Cooley Engr. Co., New York.

Engines, Steam

American Engine Co., Bound Brook, N. J.
American & British Mfg. Co., Providence, R. I.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., Elizabethport, N. J.
Bass Foundry & Mach. Co., Fort Wayne, Ind.
Beggs & Co., James, New York.
Buckeye Engine Co., Salem, O.
Buffalo Forge Co., Buffalo, N. Y.
Chuse Engine & Mfg. Co., Mattoon, Ill.
Clark Bros. Co., Belmont, N. Y
Cooper Co., C. & G., Mt. Vernon, Ohio.
De La Vergne Mach. Co., New York.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fishkill Landing Machine Co., Fishkill-on-the-Hudson, N. Y.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Green Fuel Economizer Co., Matteawan, N. Y.
Greenfield, Steam Engine Works, Harrison, N. J.
Griffith & Wedge Co., Zanesville, O.
Griscom-Spencer Co., New York.
Harrisburg Fdry. & Mach. Works, Harrisburg, Pa.
Harris Steam Engine Co., Wm., A., Providence, R. I.
Hewes & Phillips Iron Works, Newark, N. J.
McIntosh, Seymour & Co., Auburn, N. Y.
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Morris Machine Works, Baldwinsville, N. Y.
Murray Iron Works Co., Burlington, Iowa.
Providence Engr. Works, Providence, R. I.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Riverside Engine Co., Oil City, Pa.
Rollins Engine Co., Nashua, N. H.
St. Louis Iron & Mach. Works, St. Louis, Mo.
Skinner Engine Co., Erie, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Vilter Mfg. Co., Milwaukee, Wis.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Mach. Co., Pittsburg, Pa.
Wheeler Condenser & Engineering Co., New York.
Wickes Bros., Saginaw, Mich.
York Mfg. Co., York, Pa.

Exhaust Heads

Burt Mfg. Co., Akron, O.
Direct Separator Co., Syracuse, N. Y.
Gardner Governor & Separator Co., Quincy, Ill.
Hoopes Mfg. Co., Springfield, O.
Loew Mfg. Co., Cleveland, O.
Ohio Blower Co., Cleveland, O.
Patterson & Co., Frank L., New York.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Sterling Blower & Pipe Mfg. Co., Hartford, Conn.
Sturtevant Co., B. F., Hyde Park, Mass.
Whitlock Coil Pipe Co., Hartford, Conn.
Wright Mfg. Co., Detroit, Mich

Exhausters, Gas

Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.

Fans, Electric

General Electric Co., Schenectady, N. Y.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
Wing Mfg. Co., L. J., New York.

Fans, Exhaust

Anderson Co., V. D., Cleveland, O.
Buffalo Forge Co., Buffalo, N. Y.
C & C Electric Co., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
Wing Mfg. Co., L. J., New York.

Feeders, Boiler

American Boiler Economy Co., Philadelphia, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Union Steam Pump Co., Battle Creek, Mich.

Feeders, Furnace

Ohio Blower Co., Cleveland, O.
Sterling Blower & Pipe Mfg. Co., Hartford, Conn.

Filters, Feed Water

Eclipse Feed Water Heater & Purifier Co., Oshkosh, Wis.

Filters, Oil

Beggs & Co., James, New York.
Burt Mfg. Co., Akron, O
Flower Steam Specialty Co., Walter L., St. Louis, Mo.
Houghton & Co., E. F., Philadelphia, Pa.
Liberty Mfg. Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Wright Mfg. Co., Detroit, Mich.

Firebox Blocks

McLeod & Henry Co., Troy, N. Y.

Fittings, Ammonia

York Mfg. Co., York, Pa.

Fittings, Boiler

Lunkenheimer Co., Cincinnati, O.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Fittings, Flange

Williams Valve Co., D. T., Cincinnati, Ohio.

Fittings, Pipe

Lunkenheimer Co., Cincinnati, O.
Mcilvea & Co., James, Chicago, Ill.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Valve & Fittings Co., Barberton, Ohio.
Pittsburgh Valve, Foundry and Construction Co., Pittsburg, Pa.
Trimont Mfg. Co., Roxbury, Mass.

Flanges

Ball & Wood Co., Elizabethport, N. J.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Jefferson Union Co., Lexington, Mass.

Flanges, Forged Steel

American Spiral Pipe Works, Chicago, Ill.

Floats

Anderson Co., V. D., Cleveland, Ohio.
Hercules Float Works, Springfield, Mass.
Reliance Gauge Column Co., Cleveland, Ohio.

Floor Stands

Chapman Valve Mfg. Co., Indian Orchard, Mass.

Flue Gas Analysis Instruments

Pierce Co., Wm. R., Buffalo, N. Y.

Forges

Buffalo Forge Co., Buffalo, N. Y.
Wing Mfg. Co., L. J., New York.

Forgings, Drop

Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Iron and Steel

Griscom-Spencer Co., New York.

Fuel Economizers

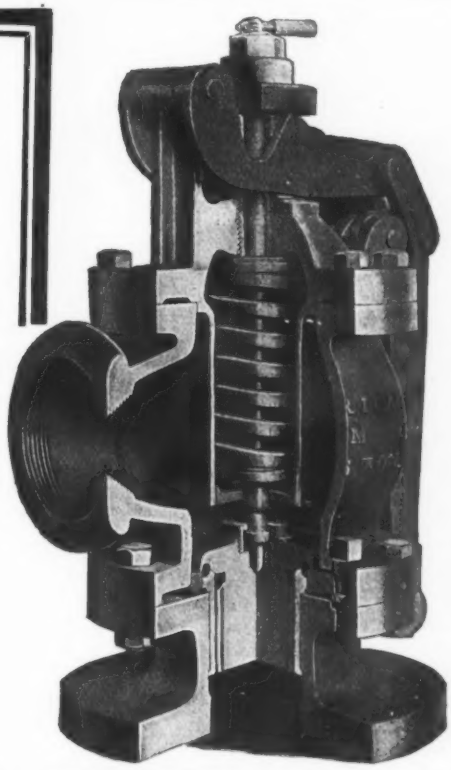
Green Fuel Economizer Co., Matteawan, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnace Tile

C-O-Two Furnace Co., Syracuse, N. Y.

Excess Pressure cannot exist on your boilers when equipped with

SIMPLICITY
QUALITY
RELIABILITY
SAFETY
DURABILITY



The American Special Pop Safety Valve

¶ The American "Special" relieves fully, closes quickly and has a greater capacity of blow-off than any other safety valve made.

Absolute Protection

¶ No possible emergency is too great for it.
¶ Positive in action, simple in construction, with the best adjustment in existence.
¶ Investigate this valve before you buy.

American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg. Chicago, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex
Montreal, 444 St. James St.

San Francisco, 247 Pine St.
Los Angeles, 213 So. Los Angeles St.

When ordering gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, be sure to specify those manufactured by us. Your interests can be best served by the protection they afford.

Furnaces, Annealing
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Forging
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Hardening
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Melting
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Smokeless
McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Wilkinson Mfg. Co., Bridgeport, Pa.

Furnaces, Tempering
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Gage Glasses
Chesterton & Co., A. W., Boston, Mass.
Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N. J.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Sterling Lubricator Co., Rochester, N. Y.
Webster & Co., Warren, Camden, N. J.

Gage Testing Outfit
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Gages, Ammonia
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Gages, Draft
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bristol Co., Waterbury, Conn.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Gages, Pressure
American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Webster & Co., Warren, Camden, N. J.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gages, Recording
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bristol Co., Waterbury, Conn.
Ohio Injector Co., Wadsworth, Ohio.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Gages, Vacuum
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gages, Water
Automatic Safety Water Gauge Co., Muskegon, Mich.
Greene, Tweed & Co., New York.
Huyette Co., Paul B., Philadelphia, Pa.
Jerguson Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Ohio Brass Co., Mansfield Ohio.
Reliable Water Gauge Co., St. Louis, Mo.
Reliance Gauge Column Co., Cleveland, O.
Wright Mfg. Co., Detroit, Mich.

Gas Producers
Broomell, Schmidt & Steacy Co., York, Pa.
Gas Machinery Co., Cleveland, Ohio.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Power & Mining Mach. Co., Cudahy, Wis.

Gaskets
American Goetze-Gasket & Packing Co., New York.
Anchor Packing Co., Philadelphia, Pa.
Carey Co., Philip, Cincinnati, O.
Detroit Leather Specialty Co., Detroit, Mich.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Houghton & Co., E. F., Philadelphia, Pa.
Johnson Co., Henry, Jersey City, N. J.
Keeler Co., E., Williamsport, Pa.
Mechanical Rubber Co., Cleveland, O.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Gaskets, Copper
American Goetze-Gasket & Packing Co., New York.

Gaskets, Leather
Detroit Leather Specialty Co., Detroit, Mich.

Gaskets, Water Gage
Johnson Co., Henry, Jersey City, N. J.
Morse, R. F., Providence, R. I.

Gears
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
New Process Raw Hide Co., Syracuse, N. Y.

Generating Sets
American Engine Co., Bound Brook, N. J.
C & C Electric Co., New York.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Foos Gas Engine Co., Springfield, Ohio.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, Ohio.

Governors, Pump
American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Davis Co., John, Chicago, Ill.
Fisher Governor Co., Marshalltown, Iowa.
Gardner Governor & Separator Co., Quincy, Ill.
Mason Regulator Co., Boston, Mass.
Strong, Carlisle & Hammond Co., Cleveland, O.
Webster & Co., Warren, Camden, N. J.

Graphite
Carpenter & Co., W. D., New York.
Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N. J.

Grate Bars
Salamander Grate Bar Co., New York.

Grates
Crowe, Paul L., Jersey City, N. J.
Salamander Grate Bar Co., New York.

Grates, Chain Traveling
Green Engineering Co., Chicago, Ill.

Grates, Clinker Cutting
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.

Grates, Dumping
Beggs & Co., James, New York.
Martin Grate Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Salamander Grate Bar Co., New York.
Thacher & Co., George H., Albany, N. Y.

Grates, Rocking
Martin Grate Co., Chicago, Ill.
Salamander Grate Bar Co., New York.

Grates, Shaking
Martin Grate Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Robertson & Sons, Jas. L., New York.
Salamander Grate Bar Co., New York.
Thacher & Co., George H., Albany, N. Y.

Grates, Stationary
Neemes Bros., Troy, N. Y.
Salamander Grate Bar Co., New York.

Grease
Carpenter & Co., W. D., New York.
Cook's Sons, Adam, New York.
Dixon Crucible Co., Jos., Jersey City, N. J.
Harris Oil Co., A. W., Providence, R. I.
Houghton & Co., E. F., Philadelphia, Pa.
Kellogg & Co., E. H., New York.
Keystone Lubricating Co., Philadelphia, Pa.
N. Y. & N. J. Lubricant Co., New York.

Grease Extractors
Beggs & Co., James, New York.
Griscom-Spencer Co., New York.
Hussey, McCann & Co., New York.

Heaters, Feed Water
Alberger Condenser Co., New York.
Baragwanath & Son, Wm., Chicago, Ill.
Beggs & Co., James, New York.
Eclipse Feed Water Heater and Purifier Co., Oshkosh, Wis.
Erie Mfg. & Supply Co., Erie, Pa.
Green Fuel Economizer Co., Matteawan, N. Y.
Griscom-Spencer Co., New York.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Kewanee Boiler Co., Kewanee, Ill.
Loew Mfg. Co., Cleveland, O.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Murray Iron Works Co., Burlington, Iowa.
National Pipe Bending Co., New Haven, Conn.
Patterson & Co., Frank L., New York.
Robertson & Sons, Jas. L., New York.
Stewart Heater Co., Buffalo, N. Y.
Tudor Boiler Mfg. Co., Cincinnati, O.
Webster & Co., Warren, Camden, N. J.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.
Wickes Bros., Saginaw, Mich.

Heating and Ventilating Systems
Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Webster & Co., Warren, Camden, N. J.
Wing Mfg. Co., L. J., New York.

Hose
Anchor Packing Co., Philadelphia, Pa.
Bowers Rubber Works, San Francisco, Cal.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Lagonda Mfg. Co., Springfield, O.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Myers & Bro., F. E., Ashland, O.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.

Hose, Air
Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

Hose, Oil
Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

Hose, Steam
Anchor Packing Co., Philadelphia, Pa.
Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

Hose, Water
Anchor Packing Co., Philadelphia Pa.
Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

Indicators, Gas Engine
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

Indicators, Speed
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Starrett Co., L. S., Athol, Mass.

Indicators, Steam Engine
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Star Brass Mfg. Co., Boston, Mass.
Trill Indicator Co., Corry, Pa.

Injectors
American Injector Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Randle Machinery Co., Cincinnati, Ohio.
Robertson & Sons, Jas. L., New York.
Schutte & Koerting Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Inspection, Boiler
Fidelity & Casualty Co., New York.

Insurance, Boiler
Fidelity & Casualty Co., New York.

Joints, Expansion
Alberger Condenser Co., New York.
Webster & Co., Warren, Camden, N. J.

Joints, Pipe
Dixon Crucible Co., Jos., Jersey City, N. J.
McCrea & Co., James, Chicago, Ill.

Joints, Rubber
Diamond Rubber Co., Akron, Ohio.

Kiln Equipment
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.

Lace, Leather
Rhoads & Sons, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Lamps, Arc
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lamps, Incandescent
General Electric Co., Schenectady, N. Y.
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Websterizing

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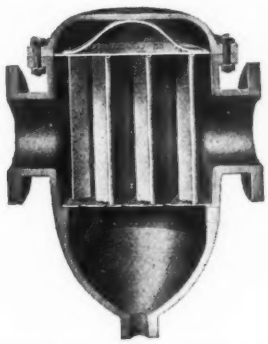
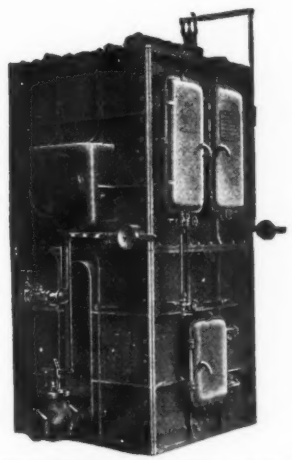


WEBSTER STANDARD HORIZONTAL OIL SEPARATOR.

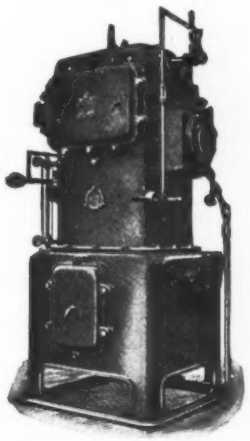
The following letter from the Palmer House, Chicago, will be of interest to all engineers who confront the problem of getting a large supply of clean, hot water, using exhaust steam:—

"In answer to your request for information concerning the Webster Feed Water Heater and Purifier installed in the Palmer House (for domestic purposes) some four years ago, I am pleased to state that we have drawn from the Webster Heater full supply of purified hot water for domestic purposes, including the entire hot water service for the Hotel, as well as kitchen and laundry.

"We were all skeptical as to the results when the Webster Heater was installed because of the fact that the exhaust steam was to be used for heating the water, steam and water coming into direct contact, our fear being that the cylinder lubricant would taint the water and make it unfit for domestic use. I am pleased to state that the Webster Separators installed with the Heater removes all the cylinder lubricant, so that we have never had a trace of oil in the water during the past years of use. In addition to removing the oil from the steam, the Webster Heater is so good a purifier as to remove practically all of the lime from the water, giving us a purified water for all purposes that is very highly appreciated. The automatic arrangement of pump attached to the hot water service insures a constant supply of hot water in every part of the building immediately upon the opening of valves in any part of the System. All the former difficulties attending the hot water service equipped with tanks and depending upon tank pressure for circulation have all been corrected and removed by the Webster method. The saving of fuel consequent upon the use of exhaust steam for the above is very large both Summer and Winter.



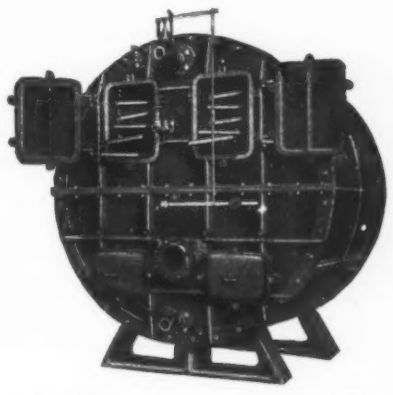
WEBSTER FEED WATER HEATER, PURIFIER AND FILTER.



THE WEBSTER FEED WATER HEATER AND PURIFIER.

"We would be pleased at any time to show the apparatus to those interested and recommend it as being the most efficient and economical water service we have ever known."

The letter is signed, "John Penrose, Chief Engineer." If you have a proposition anything like this, let us send you Heater Booklet, 12-F, and Separator Booklet, 12-S.



WEBSTER FEED WATER HEATER, PURIFIER AND FILTER.

Warren Webster & Co., Camden, N.J.

Lathes, Foot Power

Barnes Co., W. F. & John, Rockford, Ill.

Lubricants

Carpenter & Co., W. D., New York.
Cook's Sons, Adam, New York.
N. Y. & N. J. Lubricant Co., New York.

Lubricating and Oiling Devices

Lunkenheimer Co., Cincinnati, O.
Nugent & Co., W. W., Chicago, Ill.

Lubricators

Chesterton & Co., A. W., Boston, Mass.
Cook's Sons, Adam, New York.
Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
Griscom-Spencer Co., New York
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Michigan Lubricator Co., Detroit, Mich.
Ohio Injector Co., Wadsworth, O.
Robertson & Sons, Jas. L., New York.
Sherwood Mfg. Co., Buffalo, N. Y.
Sight Feed Oil Pump Co., Milwaukee, Wis.
Stephenson Mfg. Co., Albany, N. Y.
Sterling Lubricator Co., Rochester, N. Y.

Machinery, Cement

Power & Mining Machinery Co., Cudahy, Wis.

Machinery, Coal and Ash Handling

Bartlett & Snow Co., Cleveland, Ohio
Jeffrey Mfg. Co., Columbus, O.

Machinery, Conveying

Bartlett & Snow Co., Cleveland, Ohio.

Machinery, Refrigerating

De La Vergne Machine Co., New York.
Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
York Mfg. Co., York, Pa.

Machinery, Second Hand

Cleveland Belting & Machinery Co., Cleveland, O.
Hewes & Phillips Iron Works, Newark, N. J.
Randle Machinery Co., Cincinnati, Ohio.
Wickes Bros., Saginaw, Mich.

Machinery, Smelting and Mining

Moore & Co., Chas. C., San Francisco, Cal.

Machines, Blue Print

Buckeye Engine Co., Salem, O.

Machines, Crank Pin Turning

Underwood & Co., H. B., Philadelphia, Pa.

Machines, Ice

Vilter Mfg. Co., Milwaukee, Wis.

Machines, Milling, Portable

Underwood & Co., H. B., Philadelphia, Pa.

Machines, Pipe Cutting and Threading

Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Crane Co., Chicago, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Toledo Pipe Threading Machine Co., Toledo, Ohio.
Trimont Mfg. Co., Roxbury, Mass.

Machines, Reseating, Flue Cap

Lagonda Mfg. Co., Springfield, O.
Leavitt Machine Co., Orange, Mass.
Liberty Mfg. Co., Pittsburg, Pa.

Machines, Reseating, Valve

Leavitt Machine Co., Orange, Mass.

Machines, Valve Seat Planing

Underwood & Co., H. B., Philadelphia, Pa.

Machinists, General

American & British Mfg. Co., Providence, R. I.
Bruce-Meriam-Abbott Co., Cleveland, O.
Mathews, Hugh, Kansas City, Mo.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Providence Engineering Works, Providence, R. I.

Mats and Matting

Diamond Rubber Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.

Metal, Anti-friction

Allan & Son, A., New York.
Reeves Pulley Co., Columbus, Ind.

Metal, Babbitt

Reeves Pulley Co., Columbus, Ind.

Metal, Bearing

Allan & Son, A., New York.
Reeves Pulley Co., Columbus, Ind.

Metal, Metallic Gasket

Reeves Pulley Co., Columbus, Ind.

Meters, Steam

St. John, G. C., New York.

Micrometers

Starrett Co., L. S., Athol, Mass.

Mill Supplies

Quaker City Rubber Co., Philadelphia, Pa

Motors

American Engine Co., Bound Brook, N. J.
C & C Electric Co., New York.
Clark Bros. Co., Belmont, N. Y.
General Elec. Co., Schenectady, N.Y.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, Ohio.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
Wickes Bros., Saginaw, Mich.

Motors, Water

Lagonda Mfg. Co., Springfield, O.

Nipples

National Tube Co., Pittsburg, Pa

Oil and Grease Cups

American Injector Co., Detroit, Mich.
Cook's Sons, Adam, New York.
Griscom-Spencer Co., New York.
Keystone Lubricating Co., Philadelphia, Pa.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Williams Valve Co., D. T., Cincinnati, Ohio.

Oil Burners

Hammel Oil Burner Co., Los Angeles, Cal.

Oil Dash Pots

Lammert & Mann, Chicago, Ill.

Oil Reservoirs

Burt Mfg. Co., Akron, O.

Oilers, Crank Pin

Penberthy Injector Co., Detroit, Mich.

Oiling Systems

Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Oils

Cook's Sons, Adam, New York.
Dearborn Drug & Chemical Wks., Chicago, Ill.

Oils—*Continued.*

Harris Oil Co., A. W., Providence, R. I.
Houghton & Co., E. F., Philadelphia, Pa.
Kellogg & Co., E. H., New York.
New York & New Jersey Lubricant Co., New York.

Oils, Non-fluid

N. Y. & N. J. Lubricant Co., New York.

Packing, Asbestos

Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Restein Co., Clement, Philadelphia, Pa.

Packing, Flange

Carey Co., Philip, Cincinnati, O.
Chesterton Co., A. W., Boston, Mass.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Houghton & Co., E. F., Philadelphia, Pa.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robertson & Sons, Jas. L., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

Packing, Hydraulic

Anchor Packing Co., Philadelphia, Pa.
Brandt, Randolph, New York.
Chesterton Co., A. W., Boston, Mass.
Detroit Leather Specialty Co., Detroit, Mich.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Home Rubber Co., Trenton, N. J.
Houghton & Co., E. F., Philadelphia, Pa.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Schieren Co., Chas. A., New York.
Steel Mill Packing Co., Detroit, Mich.

Packing, Metallic

American Huhn Metallic Packing Co., New York.
Anchor Packing Co., Philadelphia, Pa.
Garlock Packing Co., Palmyra, N. Y.
Houchin-Aiken Co., Brooklyn, N.Y.
Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Steel Mill Packing Co., Detroit, Mich.

Packing, Piston

American Steam Packing Co., Boston, Mass.
Anchor Packing Co., Philadelphia, Pa.
Bowers Rubber Works, San Francisco, Cal.
Carey Co., Philip, Cincinnati, O.
Chesterton Co., A. W., Boston, Mass.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.

Packing, Piston—*Continued.*

National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Steel Mill Packing Co., Detroit, Mich.
Underwood & Co., H. B., Philadelphia, Pa.

Packing, Pneumatic

Detroit Leather Specialty Co., Detroit, Mich.
Houghton & Co., E. F., Philadelphia, Pa
Mercer Rubber Co., Hamilton Square, N. J

Packing, Pump Valve

Anchor Packing Co., Philadelphia, Pa.
Diamond Rubber Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Packing, Rod

American Huhn Metallic Packing Co., New York.
Anchor Packing Co., Philadelphia, Pa.
Bowers Rubber Co., San Francisco, Cal.
Brandt, Randolph, New York.
Carey Co., Philip, Cincinnati, O.
Chesterton Co., A. W., Boston, Mass.
Diamond Rubber Co., Akron, Ohio.
Flower Steam Specialty Co., Walter L., St. Louis, Mo.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Steel Mill Packing Co., Detroit, Mich.

Packing, Valve Stem

Diamond Rubber Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
Mechanical Rubber Co., Cleveland, Ohio.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Philadelphia, Pa.

Pipe

Ball & Wood Co., Elizabethport, N. J.

Pipe, Riveted Steel

Minneapolis Steel & Mchy. Co., Minneapolis, Minn.

Pipe, Wrought

National Tube Co., Pittsburg, Pa.

Pipe Coils

McCrea & Co., James, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Whitlock Coil Pipe Co., Hartford, Conn.

Piping, Blow

Ohio Blower Co., Cleveland, O.

Planimeters

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Plumbago

Dixon Crucible Co., Jos., Jersey City, N. J.

AN ENGINEER of a power plant in Ohio was having great trouble with scale in his boilers, so he wrote to a brother of his, who was running a plant in Maine, asking for advice. "Why," said the brother, "I use Blank's Compound, and have no trouble at all." ¶Whereupon engineer No. 1 bought Blank's "cure-all" and in six months had to install a new boiler. ¶All of which is but another proof of the fact that you must "make the punishment fit the crime." ¶The only way water can be treated successfully and intelligently is after a scientific analysis. ¶Hardly any two feed waters contain exactly the same ingredients. ¶Therefore, if *you* want pure water, you must find out what's wrong with *your* water---not any old water. ¶Pack a gallon of it in a clean jug or bottle with a new cork and send it to us. It's our business to tell by analysis just what you need to know before you can start treatment. ¶We will make a full report free of charge.

Geo. W. Lord Company

2238-50 North Ninth Street,

Philadelphia, Pa.

Polish, Metal

Chesterton Co., A. W., Boston, Mass.
Hoffman, Geo. W., Indianapolis, Ind.

Publishers

American School of Correspondence, Chicago, Ill.
Audel & Co., New York.
Hill Publishing Co., New York.
International Correspondence Schools, Scranton, Pa.
System Co., Chicago, Ill.

Pulleys

American Pulley Co., Phila., Pa.
Houghton & Co., E. F., Philadelphia, Pa.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Philips Pressed Steel Pulley Works, Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.

Pulleys, Clutch

Williams Foundry & Mach. Co., Akron, Ohio.

Pumps, Air

Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Warren Steam Pump Co., Warren, Mass.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Boiler Feed

Epping-Carpenter Co., South Framingham, Mass.
Kewanee Boiler Co., Kewanee, Ill.
Warren Steam Pump Co., Warren, Mass.

Pumps, Centrifugal

Alberger Condenser Co., New York.
Morris Machine Works, Baldwinsville, N. Y.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Compound

Warren Steam Pump Co., Warren, Mass.

Pumps, Deep Well

Warren Steam Pump Co., Warren, Mass.

Pumps, Electric

Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Hydraulic

Goulds Mfg. Co., Seneca Falls, N. Y.
Union Steam Pump Co., Battle Creek, Mich.
Warren Steam Pump Co., Warren, Mass.

Pumps, Oil

Burt Mfg. Co., Akron, O.
Detroit Lubricator Co., Detroit, Mich.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Sight Feed Oil Pump Co., Milwaukee, Wis.
Union Steam Pump Co., Battle Creek, Mich.

Pumps, Oil, Force-Feed

Sterling Lubricator Co., Rochester, N. Y.

Pumps, Power

Deming Co., Salem, Ohio.
Myers & Bro., F. E., Ashland, O.
Patterson & Co., Frank L., New York.
Stewart Heater Co., Buffalo, N. Y.

Pumps, Power—*Continued.*

Union Steam Pump Co., Battle Creek, Mich.
Whitlock Coil Pipe Co., Hartford, Conn.

Pumps, Steam

Buffalo Steam Pump Co., Buffalo, N. Y.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Epping-Carpenter Co., Pittsburg, Pa.
Gardner Governor and Separator Co., Quincy, Ill.
Mason Regulator Co., Boston, Mass.
Minneapolis Steel & Machy. Co., Minneapolis, Minn.
Murray Iron Works Co., Burlington, Iowa.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Union Steam Pump Co., Battle Creek, Mich.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Triplex

Minneapolis Steel & Mchry. Co., Minneapolis, Minn.

Pumps, Turbine

Alberger Condenser Co., New York.

Pumps, Vacuum

Alberger Condenser Co., New York.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Union Steam Pump Co., Battle Creek, Mich.
Warren Steam Pump Co., Warren, Mass.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Purifiers, Feed Water

Harrison Safety Boiler Works, Philadelphia, Pa.
Keyes & Son, F. E., New York.

Rams, Steam

Penberthy Injector Co., Detroit, Mich.

Reducing Wheels

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Trill Indicator Co., Corry, Pa.

Refractories

Harbison-Walker Refractories Co., Pittsburg, Pa.

Regulators, Damper

Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Mason Regulator Co., Boston, Mass.
Robertson & Sons, Jas. L., New York.
Strong, Carlisle & Hammond Co., Cleveland, O.

Regulators, Feed Water

American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Jerguson Mfg. Co., Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Mason Regulator Co., Boston, Mass.
Murray Automatic Boiler Feed Co., Detroit, Mich.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.

Regulators, Pressure

American Boiler Economy Co., Philadelphia, Pa.
American District Steam Co., Lockport, N. Y.
Davis Regulator Co., G. M., Chicago, Ill.
Fisher Governor Co., Marshalltown, Iowa.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.

Regulators, Pressure—*Cont.*

Lagonda Mfg. Co., Springfield, O.
Mason Regulator Co., Boston, Mass.
Ohio Brass Co., Mansfield, Ohio.
Strong, Carlisle & Hammond Co., Cleveland, O.

Regulators, Rheostat

Mason Regulator Co., Boston, Mass.

Repairs, Engine and Pump

Underwood & Co., H. B., Philadelphia, Pa.

Revolution Counters

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schuchardt & Schutte, New York.

Rope, Transmission

American Mfg. Co., New York.

Rubber Goods

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Griscom-Spencer Co., New York.
Home Rubber Co., Trenton, N. J.
Houghton & Co., E. F., Philadelphia, Pa.
Mechanical Rubber Co., Cleveland, Ohio.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Philadelphia, Pa.

Rust Preventers

Houghton & Co., E. G., Philadelphia, Pa.

Schools, Correspondence

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Separators, Ammonia

Harrison Safety Boiler Works, Philadelphia, Pa.

Separators, Oil

Austin Separator Co., Detroit, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
Direct Separator Co., Syracuse, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hershey Foundry & Machine Co., Manheim, Pa.
Hoppes Mfg. Co., Springfield, O.
Hussey, McCann & Co., New York.
Liberty Mfg. Co., Pittsburg, Pa.
Loew Mfg. Co., Cleveland, O.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Ohio Blower Co., Cleveland, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Webster & Co., Warren, Camden, N. J.
Wright Mfg. Co., Detroit, Mich.

Separators, Oil and Water

Harrison Safety Boiler Works, Philadelphia, Pa.
Keyes & Son, F. E., New York.

Separators, Steam

Austin Separator Co., Detroit, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
d'Este & Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Gardner Governor and Separator Co., Quincy, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hershey Foundry & Machine Co., Manheim, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Loew Mfg. Co., Cleveland, O.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Ohio Blower Co., Cleveland, O.
Patterson & Co., Frank L., New York.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.

Separators, Steam—*Continued*

Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Webster & Co., Warren, Camden, N. J.
Whitlock Coil Pipe Co., Hartford, Conn.
Wright Mfg. Co., Detroit, Mich.

Shafts, Counter

Myers & Bro., F. E., Ashland, O.

Sheaves

Minneapolis Steel & Mchy. Co., Minneapolis, Minn.

Skimmers, Boiler

Buckeye Boiler Skimmer Co., Toledo, Ohio.

Skylights

Burt Mfg. Co., Akron, O.

Smoke Preventers

Climax Smoke Preventer Co., Boston, Mass.

Specialties, Steam

Ohio Brass Co., Mansfield, Ohio.

Spray Nozzles

Schutte & Koerting Co., Philadelphia, Pa.

Stacks, Steel

Bigelow Co., New Haven, Conn.
Keeler Co., E., Williamsport, Pa.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Morrin Climax Boiler Co., Brooklyn, N. Y.

Steam Heating Supplies

Beggs & Co., James, New York.
Crosby Steam Gage & Valve Co., Boston, Mass.
Dunham Co., C. A., Marshalltown, Iowa.
Eastwood Wire Mfg. Co., Belleville, N. J.
Fisher Governor Co., Marshalltown, Iowa.
Nason Mfg. Co., New York.
New York Belting & Packing Co., New York.
Ohio Brass Co., Mansfield, O.
Peerless Rubber Mfg. Co., New York.
Reliance Gauge Column Co., Cleveland, O.
Strong, Carlisle & Hammond Co., Cleveland, O.
Wright Mfg. Co., Detroit, Mich.

Stocks, Die

Armstrong Mfg. Co., Bridgeport, Conn.
Toledo Pipe Threading Machine Co., Toledo, O.

Stokers, Mechanical

Crowe, Paul L., Jersey City, N. J.
Detroit Stoker and Foundry Co., Detroit, Mich.
Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Westinghouse Mach. Co., Pittsburg, Pa.
Wilkinson Mfg. Co., Bridgeport, Pa.

Strainers

American Injector Co., Detroit, Mich.
Liberty Mfg. Co., Pittsburg, Pa.
Webster & Co., Warren, Camden, N. J.

Superheaters

Babcock & Wilcox Co., New York.
Parker Boiler Co., Philadelphia, Pa.
Power Specialty Co., New York.
Providence Engineering Works, Providence, R. I.

Switchboards

C & C Electric Co., New York.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Switches, Electric

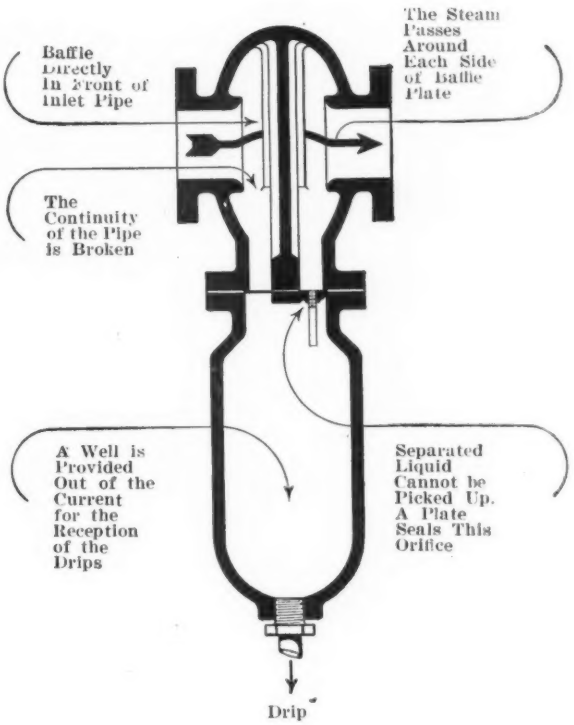
General Electric Co., Schenectady, N. Y.
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Syphons

National Tube Co., Pittsburg, Pa.
Schutte & Koerting Co., Philadelphia, Pa.

COCHRANE SEPARATORS

THE COMPLETE SEPARATOR


Baffle Directly In Front of Inlet Pipe
The Steam Passes Around Each Side of Baffle Plate
The Continuity of the Pipe is Broken
A Well is Provided Out of the Current for the Reception of the Drips
Separated Liquid Cannot be Picked Up. A Plate Seals This Orifice
Drip

The Cochrane Separator is the only steam or oil separator embodying all, or anywhere near all, of the following indispensable elements :

(1) Single, vertically-ribbed baffle plate, to stop liquid particles and conduct them to the well ;

(2) Free opening to well, directly in front of and below entering pipe, to catch large slugs of water ;

(3) Two steam ports, one each side of the baffle, offering least resistance to steam and shortest path out of the steam for the particles to be separated.

(4) Chamber beyond baffle drained, but shut off from well so that steam current cannot pick liquid up again ;

(5) Strong, compact construction ;

(6) Over 12,000 in daily, satisfactory use. Cochrane Oil Separators protect over 8,000,000 H.P. of boilers from oil ;

(7) The only separator that you can rely upon to exactly fill your needs and requirements. Send particulars and let us prove this.

HARRISON SAFETY BOILER WORKS,
17TH. & CLEARFIELD STS., PHILADELPHIA, PA.

TALK 9

Tachometers

Schuchardt & Schutte, New York.

Tanks

Bigelow Co., New Haven, Conn.
Griscom-Spencer Co., New York.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
New Bedford Boiler & Mach. Co., New Bedford, Mass.

Taps and Dies

Toledo Pipe Threading Machine Co., Toledo, O.

Thermometers

Bristol Co., Waterbury, Conn.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Tools

Mound Tool & Scraper Co., St. Louis, Mo.
Trimont Mfg. Co., Roxbury, Mass.

Transformers and Converters

General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Transmission, Power

American Mfg. Co., New York.
American Pulley Co., Philadelphia, Pa.
Gandy Belting Co., Baltimore, Md.
Jeffrey Mfg. Co., Columbus, O.
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Reeves Pulley Co., Columbus, Ind.
Rhoads & Sons, J. E., Philadelphia, Pa.

Traps

American District Steam Co., Lockport, N. Y.
Anchor Packing Co., Philadelphia, Pa
Anderson Co., V. D., Cleveland, O.
Davis Co., John, Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Dunham Co., C. A., Marshalltown, Iowa.
Flinn, Richard J., W. Roxbury Station, Boston, Mass.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
Houghton & Co., E. F., Philadelphia, Pa.
McCrea & Co., James, Chicago, Ill.
Morehead Mfg. Co., Detroit, Mich.
Nason Mfg. Co., New York.
Ohio Blower Co., Cleveland, O.
Platt & Co., John, New York.
Reliance Gauge Column Co., Cleveland, O.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.
Webster & Co., Warren, Camden, N. J.
Williams Valve Co., D. T., Cincinnati, Ohio.
Wright Mfg. Co., Detroit, Mich.

Trucks, Storage Battery Auto-

Westinghouse Mach. Co., Pittsburg, Pa.

Tube Cutters

Lagonda Mfg. Co. Detroit, Mich.

Tubing

National Tube Co., Pittsburg, Pa.

Tubing, Metallic

Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.

Tubes, Boiler, Welded and Seamless

National Tube Co., Pittsburg, Pa.

Turbines, Steam

De Laval Steam Turbine Co., Trenton, N. J.
General Elec. Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.
Wing Mfg. Co., L. J., New York.

Unions

Bard Union Co., Norwich, Conn.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Dart Mfg. Co., E. M., Providence, R. I.
Jefferson Union Co., Lexington, Mass.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

Valve Balls

Diamond Rubber Co., Akron, Ohio.

Valve Discs

Allan & Son, A., New York.
Diamond Rubber Co., Akron, Ohio.
Mechanical Rubber Co., Cleveland, O.

Valves

Liberty Mfg. Co., Pittsburg, Pa.
National Tube Co., Pittsburg, Pa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.
Ohio Brass Co., Mansfield, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

Valves, Ammonia

York Mfg. Co., York, Pa.

Valves, Angle

New Bedford Boiler & Mach. Co., New Bedford, Mass.

Valves, Automatic

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Lagonda Mfg. Co., Springfield, O
Webster & Co., Warren, Camden, N. J.

Valves, Back Pressure

Schutte & Koerting Co., Philadelphia, Pa.
Walch & Wyeth, Chicago, Ill.

Valves, Balance

Mason Regulator Co., Boston, Mass.

Valves, Blow-off

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Homestead Valve Mfg. Co, Pittsburg, Pa.
Liberty Mfg. Co., Pittsburg, Pa.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Valves, Boiler Stop

Davis Regulator Co., G. M., Chicago, Ill.
New Bedford Boiler & Mach. Co., New Bedford, Mass.

Valves, By-pass

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Mason Regulator Co., Boston, Mass.

Valves, Check

Greene, Tweed & Co., New York.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Nelson Valve Co., Philadelphia, Pa.
Pittsburgh Valve and Fittings Co., Barberton, Ohio.
Walch & Wyeth, Chicago, Ill.
Williams Valve Co., D. T., Cincinnati, Ohio.

Valves, Cylinder Relief

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

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Davis Co., John, Chicago, Ill.
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Valves, Gate

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Greene, Tweed & Co., New York.
Kennedy Valve Mfg Co., Elmira, N. Y.
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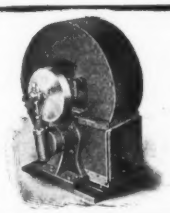

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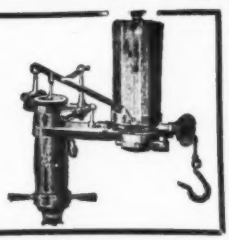

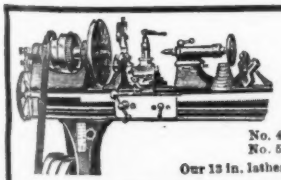

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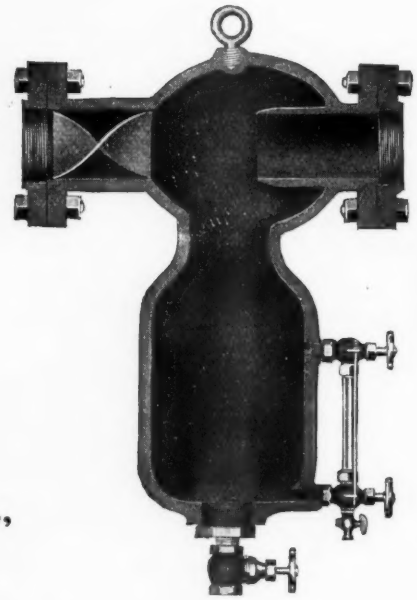

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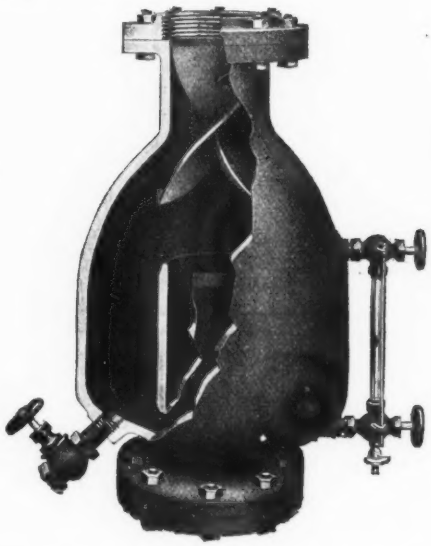

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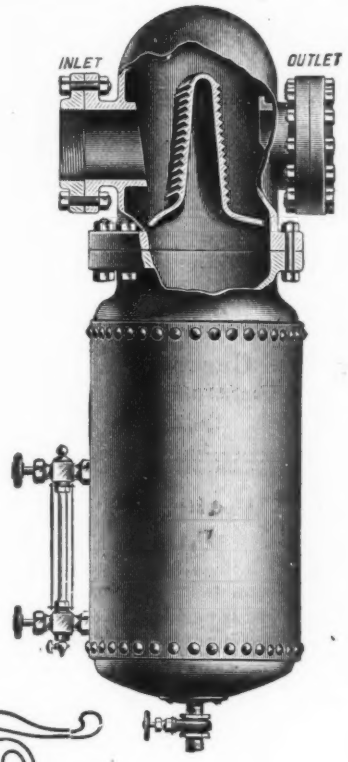

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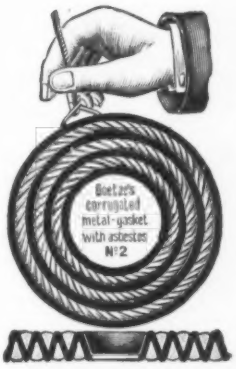

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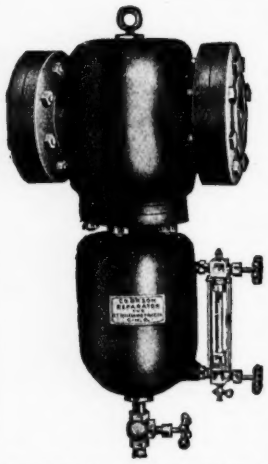

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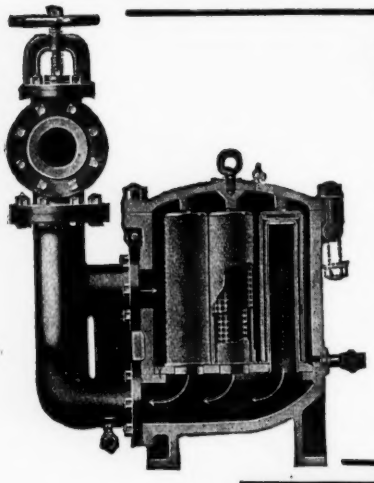

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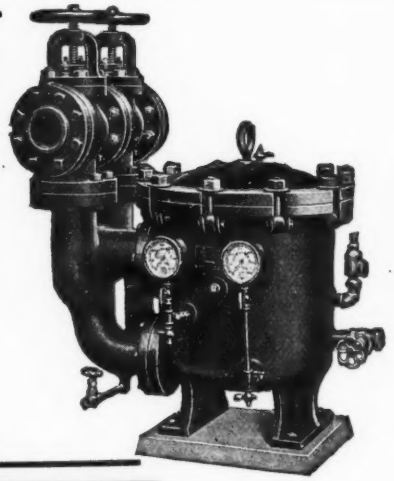

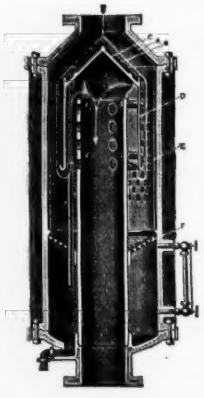

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Adapted for all conditions requiring the removal of condensation without loss of steam.

SPECIFY:

"CLASS B"—For pressures under 20 lbs.
"CLASS C"—For pressures between 20 and 70 lbs.
"SIDELUG"—For pressures higher than 40 to 150 lbs.

Send for Catalog.

NASON MFG. CO., NEW YORK.

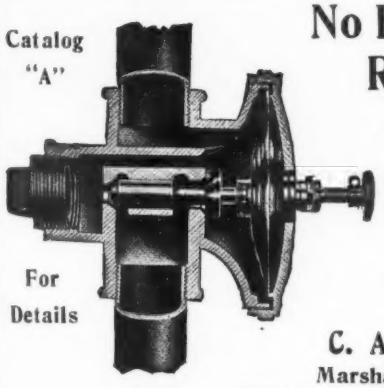
IT WEARS WELL

THE GEIPEL STEAM TRAP WORKS WELL AND WEARS WELL.

Let us send you one on trial.

John Platt & Co., 97 Cedar St., New York.

Catalog "A"



For Details

No Foundation Required

as the Dunham Steam trap is not effected by jarring or irregular motion.

It is the smallest trap in the world and has the largest capacity of any trap made.

WRITE

C. A. DUNHAM CO.
Marshallton, Iowa, U. S. A.

Chicago Cleveland Toronto Philadelphia

FLINN DIFFERENTIAL STEAM TRAPS

Save their Cost by Increasing Engine Efficiency.

THE EDWARD P. ALLIS COMPANY, Milwaukee, Wis.
[AFTER SELLING OVER 500 FLINN TRAPS.]

Replying to yours of the 17th inst., we would say that we have used the FLINN DIFFERENTIAL STEAM TRAP for a number of years, practically since its first introduction, and have found it the most general satisfactory trap we have ever used.

Yours, truly,
[Signed] THE EDWARD P. ALLIS COMPANY,
By Irving H. Reynolds.

DESCRIPTIVE CIRCULAR ON REQUEST.

RICHARD J. FLINN, West Roxbury Station, Boston, Mass.

Your dreams

can be realized.

Dreams are slumbering **ambitions** waiting for **opportunity.**

Opportunity is a force, visible only to those who are **ready** to grasp it. Your **opportunity** is right in front of you—the firm is just waiting for you to **prove up.** They don't care **who** you are—it's **what** you are.

A better position is waiting for you—**more pay**—shorter hours—cleaner and easier work—**authority**—just what you have been looking forward to and dreaming about.

PREPARE YOURSELF FOR THIS ADVANCE

The American School of Correspondence will help you in this preparation. This School has helped hundreds of Stationary Engineers and Firemen, Electricians, Draftsmen, Heating and Ventilating Engineers, Plumbers and Mechanical Engineers realize their dreams for a better and brighter future; to qualify for positions with shorter hours, easier and cleaner work and larger pay. Our courses in Stationary Engineering, Electrical Engineering, Locomotive Engineering, Drafting, Heating and Ventilating, Plumbing and Mechanical Engineering are exceptionally complete and practical—just what you need. We give the most comprehensive instruction in the usual work and lay particular stress on the Course in **Boiler** and **Engine Operation** and **Construction.**

Our **"Home Study"** course is just what **you** need to occupy your time during the long winter evenings. Bright, pleasant, interesting studies, that will rest you after a hard day at the shop. The lessons are never long enough to tire. They are written by practical, technical men.

Pick out the course that suits your taste and present employment—put your "X" before it today with a determination to make every spare moment **count** until your DREAMS ARE REALIZED.

WE HELP MEN HELP THEMSELVES.

American School of Correspondence
Chicago, U. S. A.

FREE INFORMATION COUPON
Clip and Mail Today.

American School of Correspondence:
Please tell me how I can fit myself to earn a good salary in the line of work marked "X."

—Special Engineers' Course (Preparatory to license Examinations)	—Contractor and Builder
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—Resident Engineer	—Telephone Engineer
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—Electrical Engineer	—Irrigation Engineer
—Boiler and Sheet Metal Pattern Draftsman	—Mechanical Engineer
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Name.....

Address.....

Occupation.....

Power, 11-3-08.

Strong's Vacuum Traps

¶ Will automatically drain your vacuum exhaust line after the engine is shut down and when running, will remove the condensation as fast as it forms. ¶ Are you using a vacuum oil separator or running your engines condensing?—(May we send you our A-30 pamphlet?) ¶ Remember—that with the use of a Strong's Vacuum Trap the danger of wrecked engines is eliminated. ¶ You ought to know about this trap, nothing to get out of order, no stuffing-boxes, trunnions or delicate parts to look after or adjustments to be made, and just think, not a puff of steam is required for its operation unless you wish to elevate the discharged water, then you know one pound—up two feet. Automatic and reliable and comes to you fully guaranteed. ¶ Don't blame us for being enthusiastic. We have a great device in this trap and want to send you our A-30 catalog.

The Strong, Carlisle & Hammond Company
342 Frankfort Avenue, Cleveland, Ohio

261 Centre Street
New York

54 No. 6th Street
Philadelphia

88 Broad Street
Boston

"A Marvel of Simplicity"

Marck Steam Trap

A mechanical device will require repairing in direct proportion to its simplicity of construction.

The Marck Steam Trap

has but one moveable part. It could have no less.

It requires no more effort to install or remove than it does for an ordinary valve and it is but little larger.

All parts are interchangeable and can be replaced while the trap is in position, in less than fifteen minutes.

Is absolutely automatic in its working, requiring no attention whatsoever.

Can be installed on the ceiling, wall or floor or in any other position desired.

Always open, excepting when live steam attempts to pass through, when it instantly closes.

More Than a Million in Use

Will be sent to any firm having a mercantile rating on 30 days' trial.

Guaranteed absolutely for two years.

Send for Marck Steam Trap Catalog illustrating methods of use.

E. F. HOUGHTON & CO.

240-250 W. SOMERSET ST., PHILADELPHIA, PA.

175-177 LAKE ST., CHICAGO
98-110 BATES ST., DETROIT
109 LIBERTY ST., NEW YORK
46 CORNHILL ST., BOSTON

Anderson's Improved Steam Trap

The Three Inch Water Seal

An absolute protection against loss of steam. Our steam traps will thoroughly drain any system of steam pipes, coils, dryers, etc.

It Works Automatically

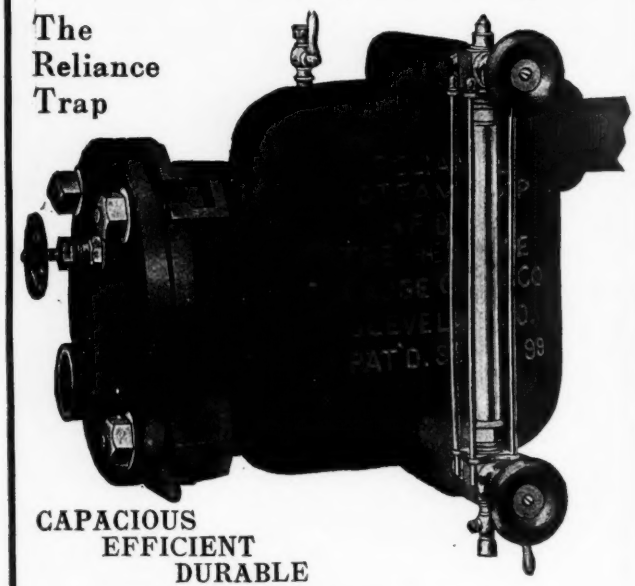
Write for our "Trap Book."

The V. D. Anderson Company

1935 W. 96th Street, Cleveland, Ohio

Exceedingly Simple

The Reliance Trap

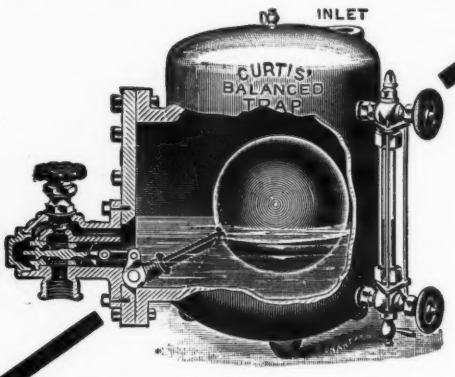


CAPACIOUS
EFFICIENT
DURABLE

Good, strong, heavy castings; put together with mechanical accuracy that insures long life and satisfactory service. *Write.*

THE RELIANCE GAUGE COLUMN COMPANY

75 E. Prospect St., CLEVELAND, O., U.S.A.



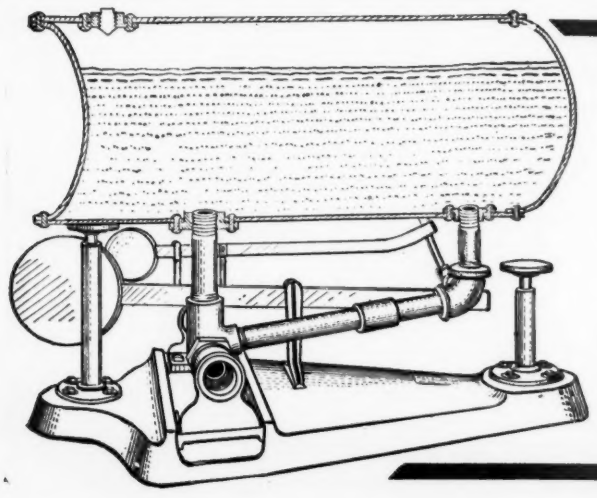
That Engineer Is Getting Satisfaction

who has a CURTIS BALANCED TRAP working for him. Its sure, positive action and absolute accuracy make it invaluable wherever a trap is needed—absolutely reliable under all conditions, works under any pressure up to 250 pounds.

Do you know the CURTIS SPECIALTIES? Write for copy of latest catalog.

Julian d'Este Company

24 Canal St., Boston, Mass.



WRITE AT ONCE FOR OUR CATALOG

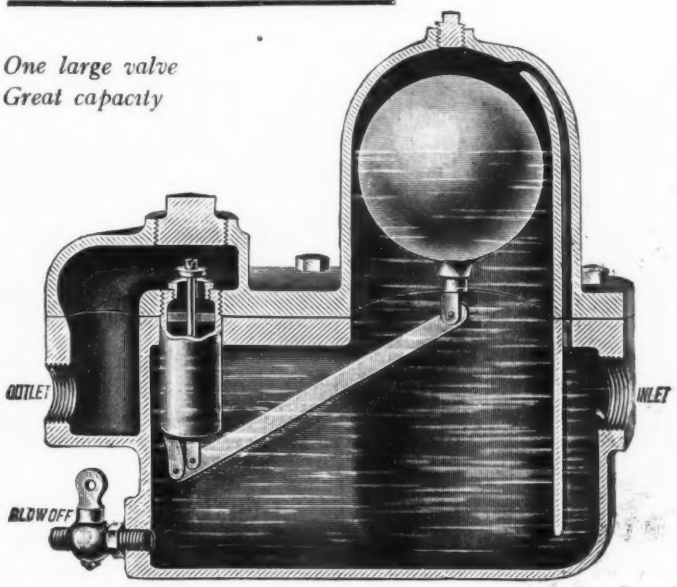
There are new ideas in it, Mr. Power Plant Man, that will simply revolutionize your opinions regarding Steam Traps.

We want to send you a copy. It is a handsome edition, representing much time, labor and money and contains information that you should know at once. The Morehead Non-return Steam Trap works by *gravity* and our Catalog explains it fully. What's your address?

Morehead Manufacturing Co.,
1051 Grand River Ave., DETROIT, MICH.

Operates perfectly whether the Steam Gauge registers No Steam or Twenty Pounds

One large valve
Great capacity



You can try this Trap 30 days and send it back at our expense if it fails.

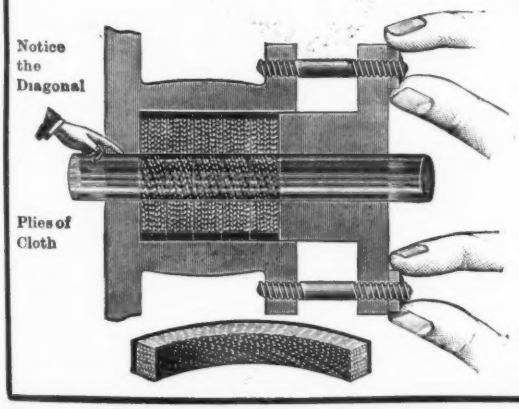
The Wright Victor Steam Trap

Drains automatically and continually the accumulating condensation from low pressure steam systems regardless of small flow or floods. Will not waste steam in the course of operation.

Draining the condensation from a steam system means the maintenance of DRY STEAM throughout the steam pipes and DRY STEAM is STEAM IN ITS MOST EFFICIENT AND ECONOMICAL STATE. Send for catalog.

Wright Manufacturing Co.
Detroit, Mich. 27 Woodbridge St.

Compressibility In Packing



Means COMPENSATION for WEAR.
It is given perfectly in

Rubberbestos (TRADE MARK REG.) **Spiral Packing**

and then again—notice the Elastic back of Rubberbestos which gives expansion on the rod-pin when it is needed.

Try this if you have Packing Troubles!

A. W. CHESTERTON CO.

or Advance Packing & Supply Co. 123 Franklin St., Chicago, Ill. **64 INDIA ST., BOSTON.**

THE PACKING WITH REAL HOLDING QUALITY

Pat. March 15 1898

DODS Diagonal Piston Rod Packing

is all one piece, made from high-grade Rubber and Duck in layers placed at a diagonal from every side. This construction gives "Dods" a cross expansion of 100%. It will hold steam, air or liquids when all other packings fail.

Send for test samples and description. Address Dept. P.

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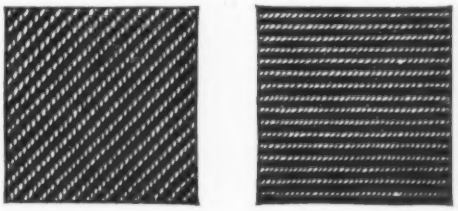

☞ **These Cross-Section Views Show Why!**

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PEERLESS SPIRAL PISTON AND VALVE ROD PACKING

IS THE MOST SATISFACTORY PACKING IN THE WORLD.
IT WILL RUN FROM 12 TO 16 MONTHS WITHOUT REPACKING.
WILL HOLD 400 POUNDS OF STEAM.
IT WILL PACK TIGHTLY ANY ROD HOWEVER BADLY SCORED AND CORRODED.
WILL NOT GET HARD UNDER ANY DEGREE OF HEAT.

SOLE MANUFACTURERS OF THE CELEBRATED
RAINBOW PACKING

PATENTED MANUFACTURED EXCLUSIVELY BY

THE PEERLESS RUBBER MANUFACTURING COMPANY

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HOME RUBBER CO. TRENTON, N.J.
STEAM
NEVER BURN BLOW OUT.
PACKING.
CHICAGO TRADE MARK NEW YORK

N.B.O.
BLACK SHEET

is the ORIGINAL Black Sheet Packing, whose wear-resisting qualities have never been equaled. It will neither burn, blow, squeeze, nor rot out, and guarantees satisfaction where other brands have failed. Look for the **N.B.O.** trade-mark—it's on every roll to protect you against inferior packings falsely claiming equal superiority.

O. I. M. IS MADE WITH TWO DIAGONAL WEDGES

which slip on each other and automatically adjust themselves to all surface variations. Thus **O. I. M.** Packing is *ideal* on scored or uneven rods. The low pressure packing is made with an absorbent cushion, while the high pressure has a round, highly elastic, hard friction tuck.

Ask your dealer—or write us direct.

HOME RUBBER COMPANY,

Woolverton Ave., TRENTON, N. J.

NEW YORK, 80 and 82 Reade St. CHICAGO, 54-60 So. Canal St

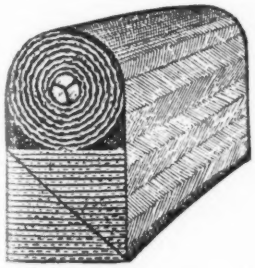
London—Balfour House, Finsbury Pavement.

O. I. M.
on its merit

Low Pressure

Use where pressure does not exceed 100 lbs.

O. I. M.
on its merit



High Pressure

Use where pressure is above 100 lbs.

Cobbs High Pressure Spiral Piston and Valve Stem Packing

The Rubber core is made of an oil and heat resisting compound, wrapped with a well frictioned Duck, with an outer cover of fine asbestos, lubricated by our secret process.

It is made round or square, in coil or spiral form especially adapted to withstand heat and high pressure. We guarantee "Cobbs" Packing will pack any rod perfectly tight, as it will not get hard under any degree of heat.

"Cobbs" Packing also furnished in rings at short notice, made of round or square packing.

Indestructible White Sheet Packing

Is without doubt the toughest and most durable High Pressure Sheet Packing on the market. It will stand the highest pressure and extreme heat, making a tight joint when used for Steam, Air, Hot or Cold Water.

It does not dry out or become hard and brittle, but retains its tough elastic qualities, either in or out of service. Ammonia, Liquor, Alkali, Oils or Acids have little or no effect on it, and joints can be broken numerous times without renewing the packing.

Indestructible White Sheet Packing is also made with wire insertion.

We manufacture a complete line of high class rubber goods, comprising Belting, Air, Fire, Garden, Steam, Suction, Pneumatic Tool and Water Hose Packings, Gaskets, Mats, Matting, Stopples, Special Mould Goods, Interlocking Rubber Tiling, Tubing, etc.

SOLE MANUFACTURERS

New York Belting & Packing Company, Ltd.

91 and 93 Chambers Street, New York, N. Y.

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THINGS don't strike everyone alike, but it would have to be an imbecile who could not appreciate *Genuine* EUREKA PACKING when once he had used it.

Eureka has every good quality a packing can have and does better work than any other on the market. *That* is pretty sure to strike everyone alike—because it means packing efficiency and economy.

Eureka is made of a pure lubricant both inside and out. It reduces friction on the rod to a lower point than any other, it does not wear the rod and it needs less repacking.

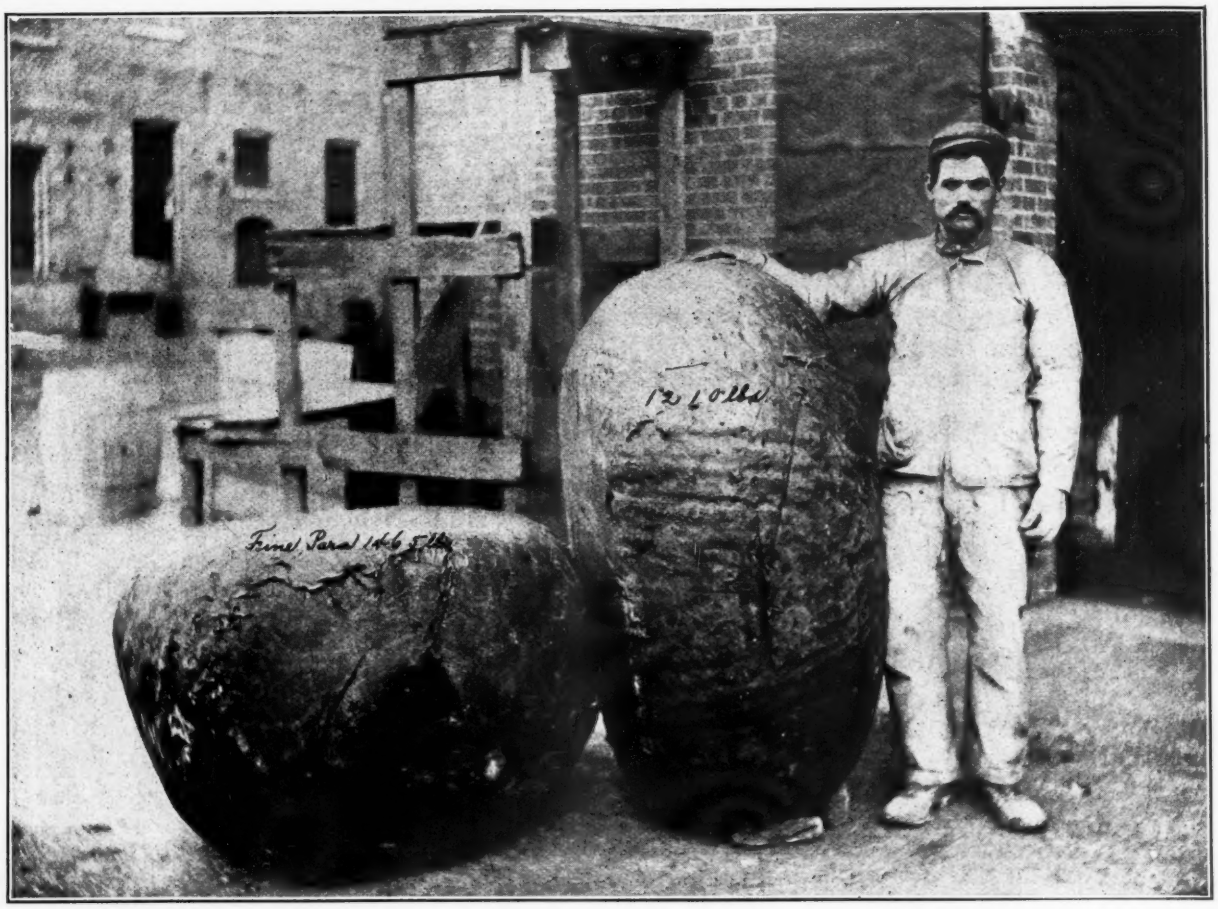
We also make highest grade Cut Ring, High Pressure, Water Proof Hydraulic, in coils and rings, Spiral and Red Sheet Packings. Write for Samples and Prices.

Eureka Packing Co.,
Jas. L. Robertson, Pres't
Sales Dept.
46 Warren Street, New York

The "man without a country" was as helpless as the Engineer without an indicator is foolish.

Any Engineer can buy the Robertson-Thompson Indicator and Victor Reducing Wheel, at a moderate price on easy terms, and *know* exactly what his engine is doing at all times and by so doing he makes himself worth more to his employer. Without it he's running on guess-work and can't possibly be sure of good results. Want the details?

JAS. L. ROBERTSON & SONS,
46 Warren Street, NEW YORK.



THE TWO LARGEST CHUNKS OF FINE PARA RUBBER

that ever reached this country came to our factory direct from the Amazon country, in South America. One of these biscuits weighs 1,465 pounds, the other 1,210 pounds.

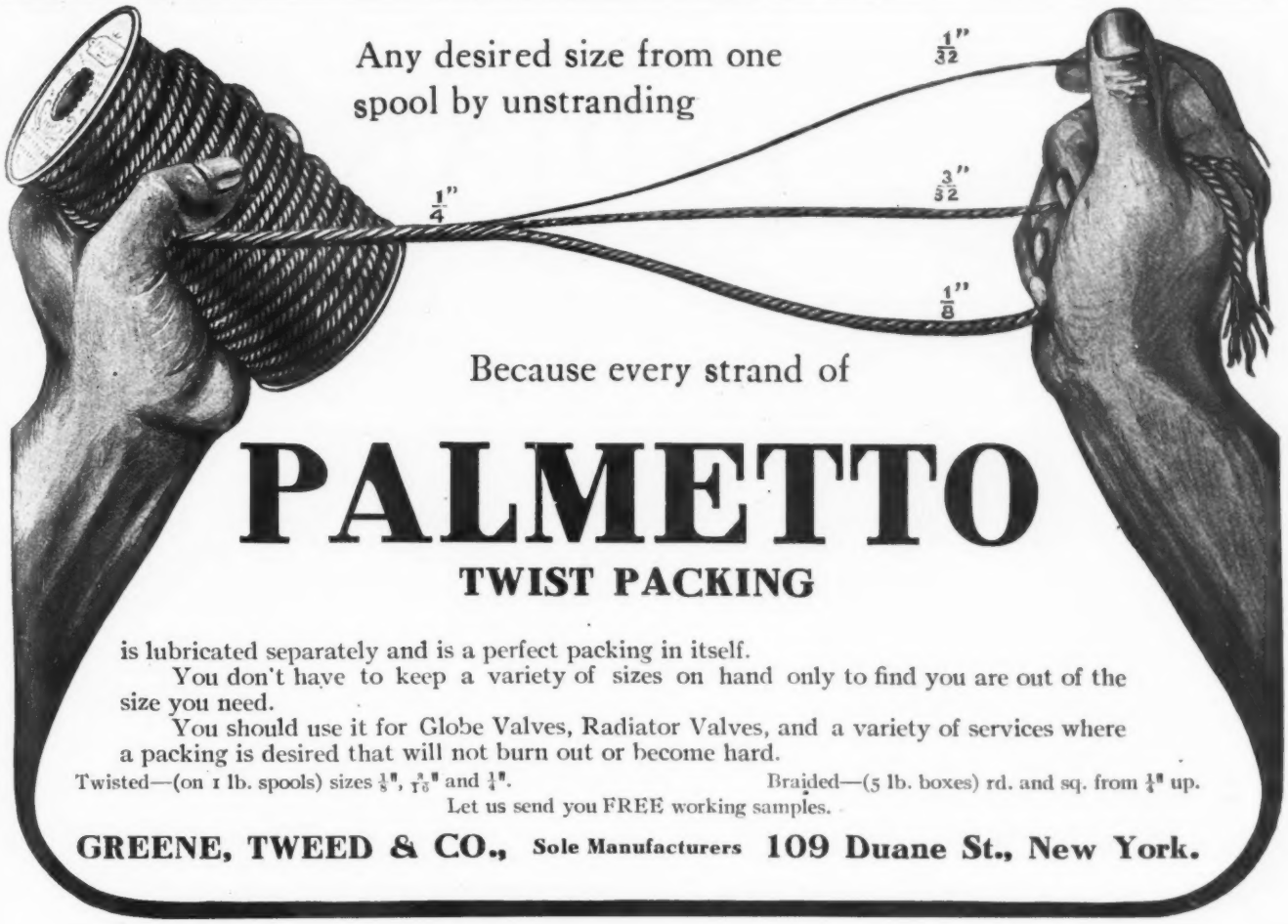
Besides being merely interesting, this picture goes to show the extent of our resources. It requires enormous shipments of the highest grade rubber to keep pace with the great demand of N. I. R. products, including among them the famous N. I. R. Packings. Investigate N. I. R. "RED SHEET."

Write for particulars.

National India Rubber Co.,

Factory: Bristol, R. I.

BRANCHES: 42 Broadway, New York. 84 Lake St., Chicago. 140 Essex St., Boston. 37 Hopkins Pl., Baltimore. 379 Washington St., Buffalo.



Because every strand of

PALMETTO

TWIST PACKING

is lubricated separately and is a perfect packing in itself.

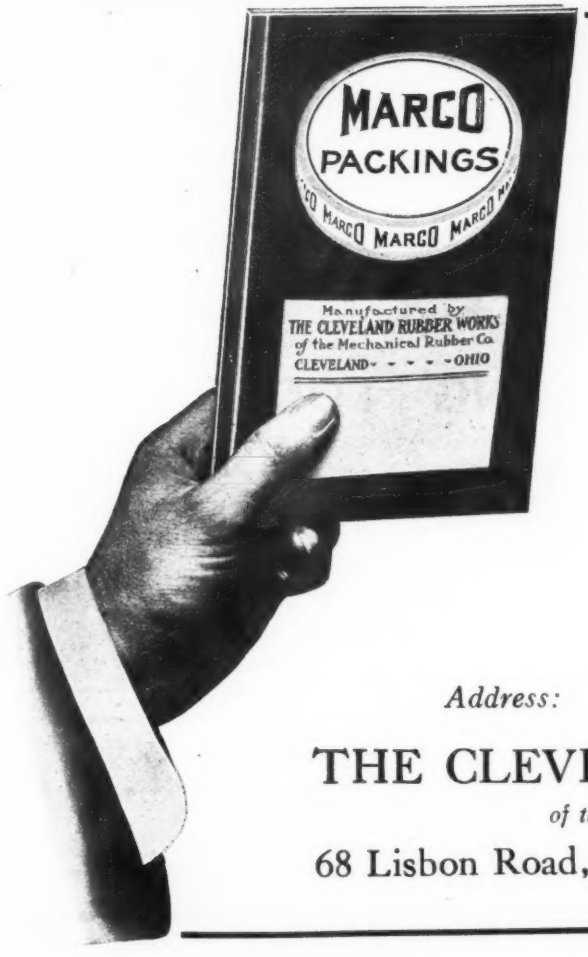
You don't have to keep a variety of sizes on hand only to find you are out of the size you need.

You should use it for Globe Valves, Radiator Valves, and a variety of services where a packing is desired that will not burn out or become hard.

Twisted—(on 1 lb. spools) sizes 1/8", 3/16" and 1/4". Braided—(5 lb. boxes) rd. and sq. from 1/4" up.

Let us send you FREE working samples.

GREENE, TWEED & CO., Sole Manufacturers **109 Duane St., New York.**



Our

TRADE MARK
MARCO
REG. IN U.S. PAT. OFF.

Packing Catalogue

for

1909

will be ready for distribution about December first.

Address:

THE CLEVELAND RUBBER WORKS

of the MECHANICAL RUBBER CO.

68 Lisbon Road, CLEVELAND, O.

ENGINEERS WHO HAVE USED

INDIAN RED SHEET PACKING

Will tell you it has the

STAYING AND RESISTING QUALITIES

It is efficient in every respect
which, in the end, means economy.

A 14 x 28 hanger, like cut herewith, but in colors,
free to any engineer upon request.

The DIAMOND RUBBER CO., AKRON, OHIO.

Complete Diamond Stocks Carried By

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1876 Broadway, N. Y.

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FREE OF ALL CHARGE

Any engineer can obtain free of all charge a set of finely made and handy packing tools. We will present them to you when you have purchased Fifty Dollars Worth of RED BREAST, OR SAYEN-REED PACKING.

ENGINEER'S PACKING TOOLS

They are made from the best selected special tool steel, and are tempered by a special process which makes them very hard while preserving their original toughness.

They will not break or bend in use, and are a great convenience to any engineer.

Full nickle plated, and highly polished.

Every engineer should have a set.

We make this special offer to interest you in our packings, knowing that if you once test them you will continue to use them.

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MERCER RUBBER COMPANY,

HAMILTON SQUARE, NEW JERSEY.

BRANCH OFFICES—Philadelphia, 421 Arcade Bldg.; New York, 250 Fulton St.; Pittsburg, Pittsburg Rubber Supply Co., 8th and Liberty Sts.; Denver, Foster & Taylor, 610 Exchange Bldg.; and Chicago, 40 Dearborn St.

WEARWELL LEATHER PACKINGS

ALWAYS THE SAME.

Made in all sizes for Hydraulic and Compressed Air Machines.

Write for Catalog and Samples.

DETROIT LEATHER SPECIALTY CO., INC.,

175 Beecher Avenue, Detroit, Mich.

BARGAINS FOR CASH.

Corliss Engines

1—12x36 Lane & Bodley	Left	Hand.
1—18x42 Allis	Right	"
1—18x36 Ohio, heavy duty	"	"
1—24x30 Clark, " "	Left	"
1—24x48 Hamilton, Girder	Right	"
1—30x48 Whitehall, heavy duty	"	"
1—20x30 Buckeye automatic, heavy duty	"	"

Automatic engines from 20 to 300 H.P.

Boilers

1—60x16— 80 H.P. Hor. tubular	100 lbs.
2—66x16—100 " " "	1—100 lbs., 1—125 lbs.
3—72x18—150 " " "	100 lbs.
20—72x18—150 " " "	125 "
4—250 H.P. Heine water tube	140 "

Heaters

1—100 H.P. Berryman	
1—500 H.P. Cochran	Open
1—500 H.P. Harrison	"
1—500 H.P. Colles	"

Belting (leather) up to 48" three ply, pulleys, shafting, and hangers.

The Cleveland Belting & Machinery Co.

Cleveland, Ohio.

BELMONT "HYDRAULIC" Style No. 8

is stitched through and through crossways; it can't swell, can't pinch, can't be twisted apart, can't do anything in fact, except stay right where it's put and keep the pump absolutely water tight with the least possible friction. Observe its construction—First, a core of finest braided flax, soft and tough.

Around three sides of this a casing built up of alternate layers of the best rubber and cotton duck, with the edges turned toward the rod, thereby insuring great durability. Then the cross stitching as described. Could anything be better? We think not, and the testimony of engineers who use Belmont Hydraulic No. 8 is that it's as near perfection as anything gets to be in this world below.

For every kind of pumping service and hydraulic machinery, and especially valuable when exposed to alkaline or sulphuric acid mine waters. Write for booklet C.

FREE Send for sample ring and be convinced. **FREE**

CLEMENT RESTEIN CO., Philadelphia, Pa.

Gentlemen:—Send me a sample ring of Belmont Hydraulic Packing, Style No. 8.

Name.....

Address: St. No..... City..... State.....

Firm Name.....

Number of Engines.....

Number of Pumps.....

Number of Boilers.....

High or Low Pressure.....

Packing now in use.....

Power, Nov. '08.

CLEMENT RESTEIN CO.,

133 N. Second St., Philadelphia, Pa.

Mfgrs. of every variety of packing and gaskets. General catalog on request.

Salesmen Wanted

To call at power plants, pumping stations and engine rooms and sell BELMONT PACKINGS and Specialties. Particularly attractive proposition for manufacturers, agents and engineers in territory not already covered.

CLEMENT RESTEIN CO., 133 N. Second St., Philadelphia, Pa.

"SAFETY"
PLASTIC
METALLIC PACKING

For Steam, Water, Air, Gas, Hydraulic Machines, Valves, Etc.

Guaranteed to stand Steam Temperature up to 550° F. and Hydraulic Pressure to 5000 lbs. per square inch.

Highest Award World's Fair, St. Louis.

Send for **FREE SAMPLE** and particulars.

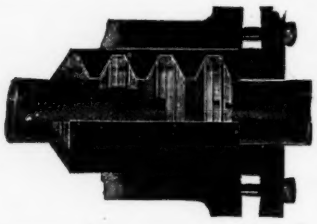
MANUFACTURED BY

STEEL MILL PACKING CO., Detroit, Mich., U.S.A.

The Quality Never Varies

The material from which Selden Packing is made would seem unnecessarily expensive to other manufacturers but the Selden reputation is worth all it has cost.

RANDOLPH BRANDT, 72 Cortlandt St., N. Y.



It keeps the Rods smooth and lasts as long as the Engine

STERLING METALLIC PACKING is far superior to any other. It is designed to stand **any pressure** and is made in three section rings, each ring being a valve seat in itself, elastic and easily worked. It will not corrode the rod when the engine is idle and pays its cost over and over in the saving of soft packing bills. Every inch of our packing is made to order, fully guaranteed and sold on trial. **Write for catalog.**

MONARCH STEAM BLOWER CO., - Troy, N. Y.

The World's Greatest Sheet Packing Is

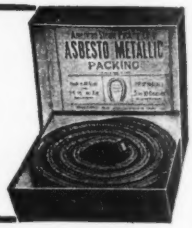
"THURIL"

It can be used repeatedly as often as 40 times.

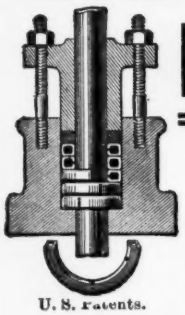
THE ANCHOR PACKING CO.
Philadelphia, Pa.

American Asbesto-Metallic Packing.

Perfect for high pressure. Semi-metallic, packs like fibrous packing, wears like metallic and gives more satisfaction than either. Ask us just how it is made, or, better yet, get a sample and see for yourself.



American Steam Packing Company,
51 High Street, Boston, Mass., U. S. A.



U. S. Patents.

Huhn Packing

LUBRICATES THE ROD PERFECTLY

Huhn Packing is easier to install, cheaper to maintain and far more durable than any other on the market.

WRITE FOR SAMPLE AND BOOKLET.

American Huhn Metallic Packing Company,
1876 Broadway, New York City.

True Merit

is found in Johnson's Packings.

There isn't a single detail regarding their manufacture that we wouldn't gladly share with you. Examine our packings and you find only the *best materials*—nothing secret.

Write for handsome catalog.

The HENRY JOHNSON CO.,
175-187 Gates Avenue, Jersey City, N. J.

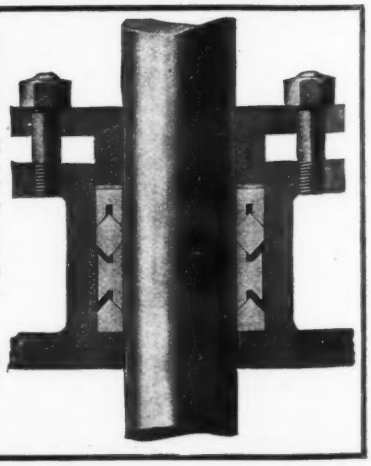
BOOKS

We are publishing the best books for engineers—we handle all books of all publishers. When you get up against a knotty question, write us and if there is a good book to help you out, we can supply it.

HILL PUBLISHING COMPANY,
505 PEARL ST., NEW YORK.

LAW

Improved Metallic Packing is best because it is the simplest. What's the use of bothering with a packing that requires springs when the "Law" requires *none*? 'Tis easy to apply, the rings are interchangeable and friction is reduced. *Booklet?*



HOUCHIN-AIKEN CO.,
Sole Manufacturers,
113-121 FIFTY-THIRD STREET,
BROOKLYN, N. Y.

Nelson Valves

Advantages Gained By Rigid Testing

The main parts of Valves are made of iron, steel, nickel and bronze castings. In our manufacture of these castings, ingenuity and skill has reduced the occurrence of flaws to a minimum, but the expert does not exist who can wholly prevent them. Careful inspection is therefore required at every stage of their manufacture, from the time they leave the foundry department until they are assembled, ready for the final test.

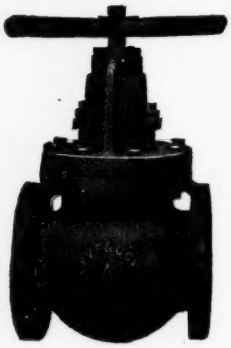
Each valve is then rigidly tested for the extreme service it is to perform, so that the slightest flaw or weakness that may have escaped surface inspection is detected, the faulty part destroyed, a perfect part substituted, a subsequent successful test made, and satisfactory service made certain. The user is thus protected against the slightest fault that might occur in manufacture from causes beyond human control.

Extra Heavy Valves for 300 pounds working pressure are tested to 800 pounds on the principle that the test pressure should provide for 300 pounds maximum working pressure, plus water hammer, plus contraction or expansion strains, plus unusual shock or stress of *any sort*. Medium Pressure Valves for 175 pounds working pressure are similarly tested to 500 pounds, and Standard Valves for 125 pounds working pressure are tested to 250 pounds.

The same principle is applied in the testing of each and every valve that carries our name—and therefore our absolute and express guarantee.

The Nelson Valve Company
Philadelphia

New York, Hudson Terminal Bldg.
Chicago, - 40 Dearborn Street
Pittsburgh, - 525 Third Avenue
Minneapolis, - 622 Andrus Bldg.
San Francisco, - Atlas Building
Butte, Mont., - 56 E. Broadway



VALVES

Makes no difference what kind of a Valve you want, how you want it made or where you want it shipped, we can supply it on shortest possible notice.

We manufacture valves and pipage equipment of every description, for all kinds of plants, Steam Separators, Tuyere Cocks, Brass Unions, Etc. Also make Pipe Bends, and do all kinds of Pipe Fitting, either assembled or ERECTED.

SEND FOR CATALOG

PITTSBURGH VALVE FOUNDRY & CONSTRUCTION CO.

Pittsburgh Cleveland New York Boston Birmingham, Ala.

Koerting Chimney Ventilator

There is no better means for improving Chimney Draft in Coke-Ovens, Land and Marine Boilers, etc., than by installing one of these Steam-Jet Blast Nozzles. They overcome the causes of bad-draft, and give quick fire and more perfect combustion. They have no moving parts, require no engine to operate—just a small steam pipe. The price is small, and will pay for itself in a short time. Installation is very simple and inexpensive.

Write for Catalog 4-B.

SCHUTTE & KOERTING CO.,

Tompson and 12th Streets, Philadelphia.

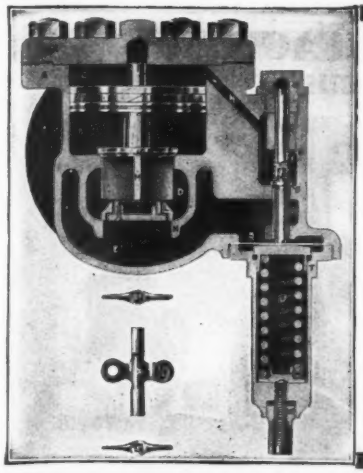
New York: 50 Church Street.
Boston: 98 High Street.
Pittsburg, Keenan Building.
Chicago: 805 Security Bldg.

Try "The Reeves" "C" Bearing Metal

It's different, newer and better than any other, and is absolutely unequalled for all factory and machinery bearings. Sells for 25c a pound at all dealers, or can be bought from us direct in 50-lb. trial boxes.

REEVES PULLEY CO.

COLUMBUS, IND.

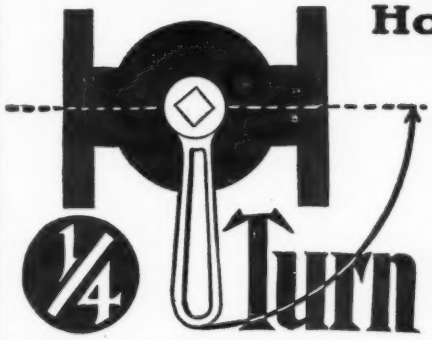


Another Exclusive Feature

of the Collin Steam Pressure Regulating Valve is that the supplementary piston (L) cuts off the velocity of the steam *before* the main valve (J) seats in closing, thus preventing hammering or cutting of the main valve. Other interesting and exclusive features explained in booklet P-B. Write for copy today.

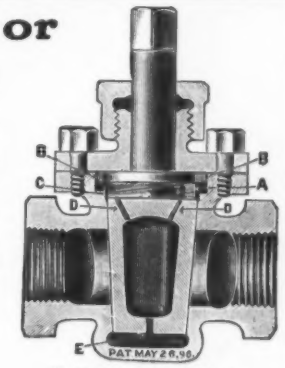
The Ohio Brass Co., Mansfield, Ohio., U. S. A.

32 Cortlandt Street, NEW YORK 277 Dearborn Street, CHICAGO 138 Front Street, SAN FRANCISCO



Homestead Valves Open or Close With A ¼ Turn

The plug is balanced and held in place by pressure when open; when closed it is locked by the patent wedging cam. There is no friction and the seats are protected from wear, which makes the "Homestead" almost indestructible. There is no better blow-off valve made. Ask for a copy of our descriptive booklet.



Homestead Straightway Balance Plug Valve Locks by Quarter Turn.

HOMESTEAD VALVE MFG. CO., Pittsburg, Pa., U.S.A.

BRASS FOUNDERS

Whale Brand Valves

Cheap valves stick their buyers, and often (through faulty construction) get stuck themselves.

NEW BEDFORD VALVES are made with extreme care from the very best materials. They are not simply slapped together to sell, but are *scientifically constructed* with the view of meriting re-orders. The more particular you are, the better you will appreciate New Bedford "Quality".

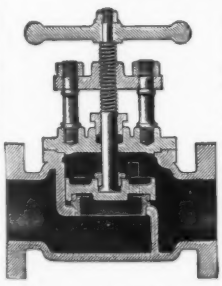
Write for Complete Catalog.

New Bedford Boiler & Machine Co.,

ESTABLISHED 1872.

New Bedford, Massachusetts.

"BELLVILLE VALVES"



have the seat on the outside of an inverted cone where the direct current of steam does not come in contact with it, preventing all chance of wire drawing. Other features in catalog.

Heavy, Compact, Durable,

no marring by pipe tongs.

Eastwood Wire Manufacturing Co.,

BELLEVILLE, NEW JERSEY.

Over 600,000 of Kunkle's Patent Lock-up Pop Safety Valves now in actual use.

For Portable, Stationary, Locomotive and Marine Boilers. They meet every requirement. We also make Mufflers for Locomotives. Write for details and prices.

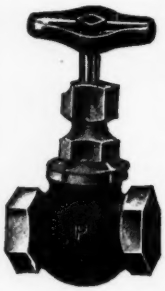
Fort Wayne Safety Valve Works,

E. B. Kunkle & Co.,

817 Barr St., Fort Wayne, Ind.

Insist on Pittsburgh Valves

and Fittings. It is impossible for human skill to produce better or more reliable equipment than that stamped with the sign of quality—"P."



Pittsburgh Brass Globe Valves

Made in a superior manner of the highest grade steam metal and sold under our binding guarantee.

If better work and longer life mean anything to you, insist on "P" products.

PITTSBURGH VALVE & FITTINGS COMPANY

General Offices and Works: BARBERTON, O.

WE MANUFACTURE ALL KINDS OF VALVES AND FITTINGS

YORK MANUFACTURING CO.,
YORK, PA.

We manufacture all the machinery and parts needed to equip a complete Ice or Refrigerating Plant—Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings of all kinds.

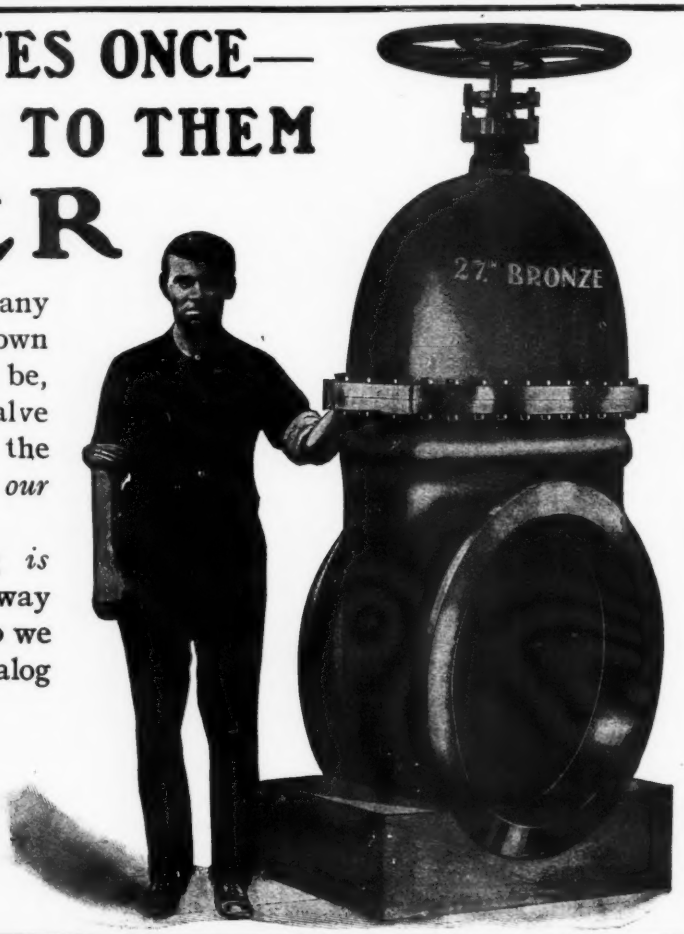
We employ over 1250 men in the manufacture of Ice and Refrigerating machinery exclusively.

CATALOG UPON REQUEST.

Our fittings carried in stock at the following places:

York Manufacturing Co.,	1631 Monadnock Block,	Chicago, Ill.
York Manufacturing Co.,	72-76 Trinity Place,	New York, N. Y.
York Manufacturing Co.,	20 South Main St.,	St. Louis, Mo.
York Manufacturing Co.,	318 Liberty Ave.,	Pittsburg, Pa.
York Manufacturing Co.,	13 S. Forsyth St.,	Atlanta, Ga.
Wegner Machine Co.,	Perry and Mississippi Sts.,	Buffalo, N. Y.
United Iron Works,	251 E. Second St.,	Los Angeles, Cal.
United Iron Works,	Second & Jefferson Sts.,	Oakland, Cal.
United Iron Works,	19 Main St.,	Seattle, Wash.
Braman, Dow & Co.,	239-245 Causeway St.,	Boston, Mass.

TRY LUDLOW VALVES ONCE— YOU'LL HOLD ON TO THEM FOREVER

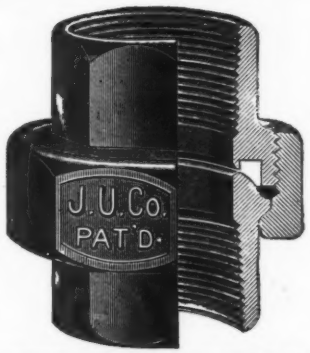


You'll always use them in preference to any other make. If you set down your own ideals of what a perfect valve should be, and then made it yourself, the finished valve wouldn't be one whit better than the "LUDLOW" TRADE MARK—probably not as good, for *our experience* is broader than yours.

"Seeing is believing"—and "*testing is proving.*" Test Ludlow Valves any way you please—we test 'em all *ourselves*, so we *know* they're "*right.*" Complete catalog on request.

THE LUDLOW VALVE MFG. COMPANY

Adams Street, TROY, N.Y., U.S.A.



It Takes Brass

in just the right proportion to make a perfectly tight union. The Jefferson Union is made of malleable iron—in which is set a bronze collar. The "Jefferson" stands for an "always tight" joint.

Write for Catalog.

THE JEFFERSON UNION CO.,
31-37 Fletcher Street, Lexington, Mass.

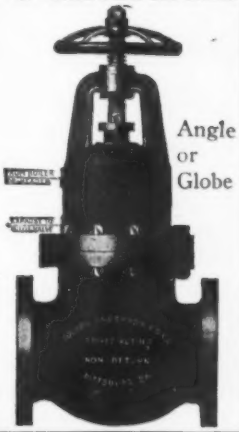
"3 VALVES IN ONE"

"THE ANDERSON"

Cushioned Non-Return and Triple Acting
"Works Both Ways"

"The Life and Property Insurance Valves"
Protect Your Power Station with the Valves that are Absolutely Guaranteed.

References;
National Tube Co.
Armour & Co.
Illinois Steel Co.
American Steel & Wire Co.
Chicago Brass Co.
H. C. Frick Coke Co.
West Va. Pulp & Paper Co.



Angle or Globe

GOLDEN-ANDERSON VALVE SPECIALTY CO.
1017 Fulton Building, Pittsburg, Pa.

The Value Mark For Valves

is the Chapman Trade Mark. There is no better guarantee. Write.

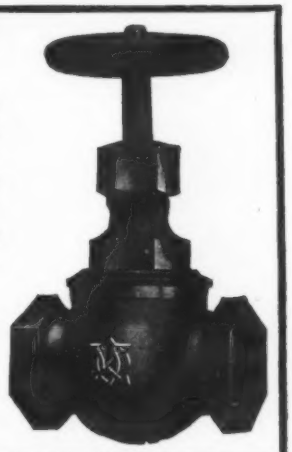
Chapman Valve Mfg. Company,
Indian Orchard, Mass.

THE VALVE DISCS CONFORM

to all uneven surfaces because they are made of a special compressible composition. And the Discs are renewable—that's another good point. We want you to know more about this Kennedy Valve.

We Make
Gate and Check Valves, too
Write for Catalog.

The Kennedy Valve Mfg. Company,
Elmira, N. Y.



STEAM PIPE COVERING

Magnesia, Asbestos, Air Cell,
Wool Felt, Hair Felt, Mineral Wool.

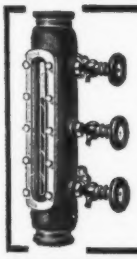
Estimates given and work executed promptly.

ROBERT A. KEASBEY COMPANY,
100 N. Moore Street, -:- New York City.

Erwood Swing Gate Valves

Manganesite Paste for Joints

WALCH & WYETH, 87 Lake St., Chicago.



RELIABLE WATER GAUGE

WRITE.

RELIABLE WATER GAUGE CO.
1616B Pine St., St. Louis, Mo.

The "Kewanee" Union

Octagon Pattern.

Has but 3 parts—no INSERTED parts.
Ball joint seat.
Brass-to-iron contact.
Brass-to-iron thread connection.
Never rusts—nor corrodes.
Needs no gasket.
Easily disconnected.
No hammering needed.
Can be used repeatedly.
Never leaks.
Tested by air pressure under water.

NATIONAL TUBE COMPANY,
PITTSBURG, PA.

District Sales Offices:

Atlanta Chicago Denver New Orleans New York Philadelphia Pittsburg Portland St. Louis San Francisco Salt Lake City Seattle

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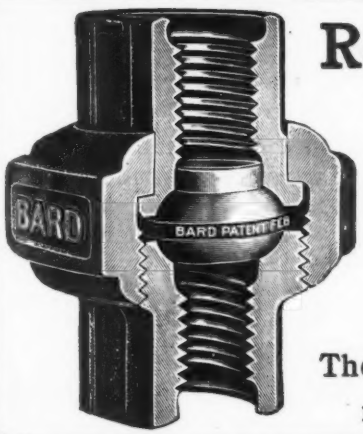

Reuseable

The recessed ends of the Bard Union make possible repeated use without spreading at the pipe ends.

Write for the "Bard" Book

The Bard Union Co.
INCORPORATED
NORWICH, CONN.

Automatic Valves Close

INSTANTLY, should the glass break in a Stulp Automatic Safety Water Gauge. At such a time, the gauge is *independent from the attention of the attendant.*

No wonder the U. S. Gov't. uses and approves these gauges. No wonder the "Stulp" won a medal and diploma at the Jamestown Exposition. Why chance a $5,000 Law Suit. Protect your men and the law protects you.

For all kinds of boilers, either locomotive, stationary, or marine.

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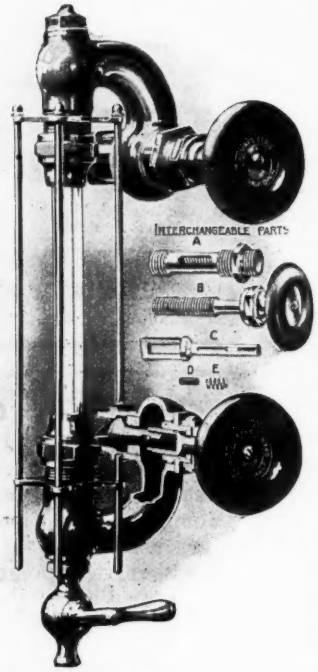


SPECIAL PRICE, $10.00

The Automatic Safety Water Gauge Co.
Fred. J. Stulp, Prop.
Muskegon, Mich.

Not only is our Reflex Water Gage the safest, most reliable and most practical gage on the market, but in addition, it can be read at a glance.

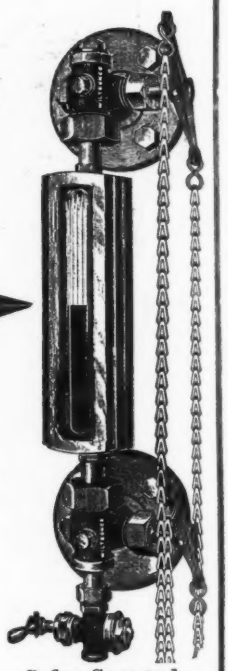
The Water Shows BLACK

—you can't fail to see it, even at a distance.

SEE IT!

Those who have experienced the trouble of *squinting* at the ordinary gage, will appreciate the "Reflex." It is used by the world's greatest navies, is easy to mount and has saved thousands of dollars.

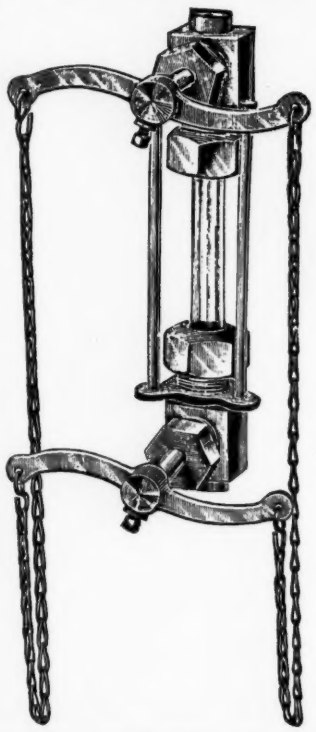
WRITE FOR CATALOG



Reflex Gage and Wiltbonco Fittings

Jerguson Mfg. Company
219 Columbus Ave., Boston, Mass.

Distance Lends Safety



to the man who has to shut off the gauge when a glass breaks.

The "P. B. H." Quick Closing Water Gauge

enables you to operate the valve from a safe distance. Its value to you depends simply on how much you value your skin.

Will you have one on 30 days' free trial?

The PAUL B. HUYETTE CO.
2025 Betz Building, Philadelphia, Pa.

"BALLWOOD" Welded Flanges

make perfectly leakless joints because the material they are made of, when welded, becomes an integral part of the pipe, expanding and contracting with it.

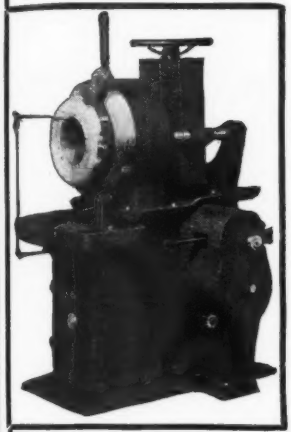
CIRCULAR 104 ?

THE BALL & WOOD CO.,
ELIZABETHPORT, N. J.
New York Sales Office, Cortlandt Bldg., 30 Church St.
BUILDERS OF BALLWOOD ENGINES

YALE UNIVERSITY
uses the Loew Victor
READ WHAT THEY SAY

"The No. 5 Loew Pipe Threading Machine has given entire satisfaction. I am especially pleased with the arrangement for adjusting dies, the removal and inserting of same, which can be done very quickly. I shall be pleased to recommend same to anyone requiring a pipe threading and cutting machine." (Signed)

H. A. BARNES,
Superintendent Steam Dept.

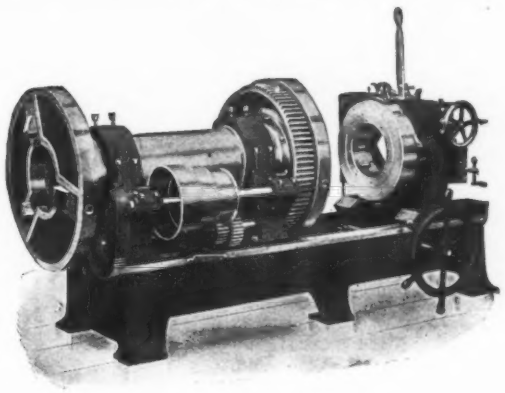


THE LOEW VICTOR

Belt, Motor and Gas Engine Driven ¼ to 8 inches.

Write for Catalog.

The Loew Manufacturing Co.
Cleveland, Ohio.



READ THIS!

"Foreman says that the machines cut the cleanest threads he has ever seen and while originally they have favored the installation of another make which they have been using for ten years, they now say they would not give the Bignall & Keeler for forty of the other make—the latter, too, is a very good machine."

Bignall & Keeler Mfg. Co.
Edwardsville, Ill.

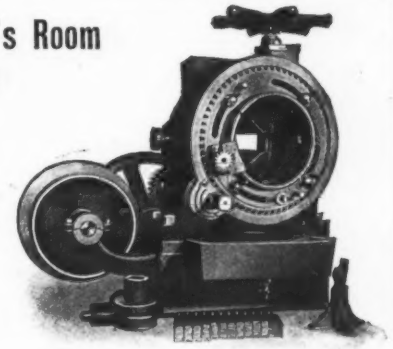
FLOATS

Not "just ordinary floats," but **Hercules Seamless Copper Floats**—the best floats made. Over 240,000 in daily use. If it's floats—get Hercules and *know you're safe from trouble.*

WRITE FOR CATALOG "B"

Hercules Float Works
P. O. Box 396 **Springfield, Mass.**

Wherever There's Room To Handle Pipe



there's room for one man and a **FORBES PATENT DIE STOCK** to cut and thread pipe up to 15" diameter at a trifling cost and in record time.

Ask for a catalog.

The Curtis & Curtis Company, 85 Garden Street, BRIDGEPORT, CONN.

Over 40,000 Toledos in Use

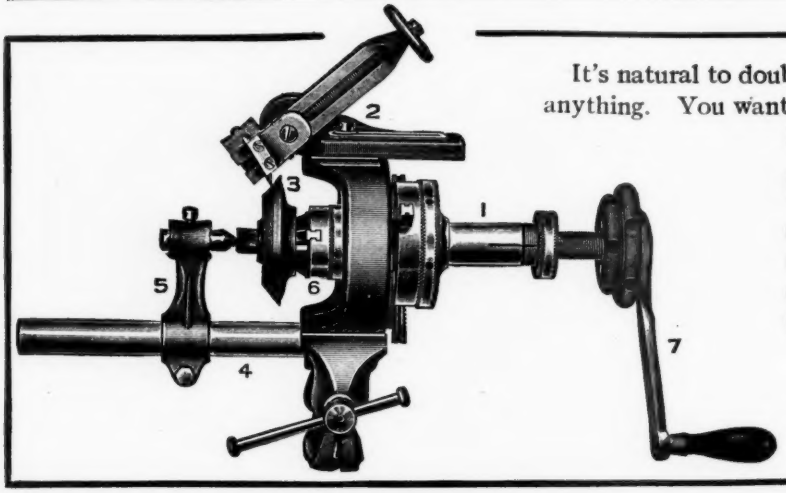
Inexpensive to Buy, Maintain and Use

light, portable, simple in construction and extremely durable.

The Toledo Pipe Threading Devices afford the highest form of economy ever attained in their line of service.

Write us and we'll tell you more about them.

The Toledo Pipe Threading Machine Co.,
TOLEDO, OHIO.



It's natural to doubt the arguments advanced by the seller of anything. You want proof that it will do your work. You can test the value of a

Dexter Valve Reseating Machine

at no risk to yourself whatever. Responsible parties can have a machine thirty days, use it all they want and then return it at our expense if they don't want it.

Send For Catalog P.

The Leavitt Machine Co.,
Orange, Mass., U. S. A.

INSERTED PARTS

Is the technical feature of the Dart Unions and Flanges. The many millions in use and the constantly increasing demand attest their merits better than pages of fulsome advertising. It requires no guide book to find the meritorious features of our products.

Two bronze seats is our Slogan. Catalogue?

E. M. DART MFG. CO., Providence, R. I.

WE make the only Gauge Glass Packing that will pack your glasses tight without the use of a wrench, Gilbert Gauge Glass Preservers—sample box, 60c. Circular?

R. F. MORSE, Providence, R. I.

They Stand Vibration

high pressures and every other gage racking condition. Ashton Gages are the standard.

WRITE

THE ASHTON VALVE COMPANY, Boston, U.S.A.
NEW YORK 81 John's House, London, Eng. CHICAGO

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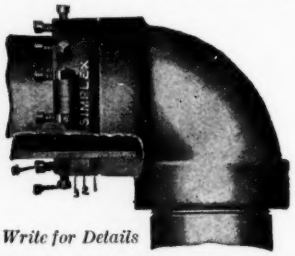
The Simplex Pipe Clamp will stop them *permanently*. Applied while the pipe is under full pressure. We'll send one for a 30 days' free trial. Test its efficiency on the worst joint in the plant.



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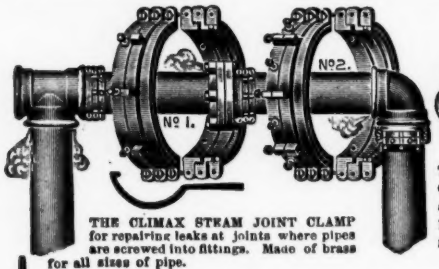

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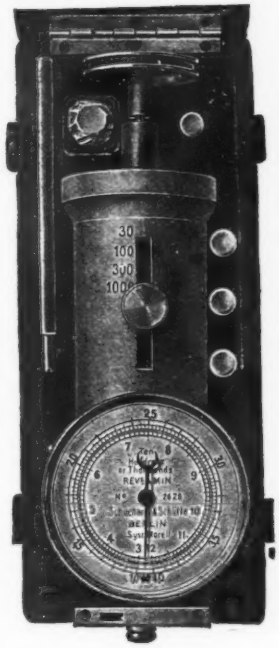

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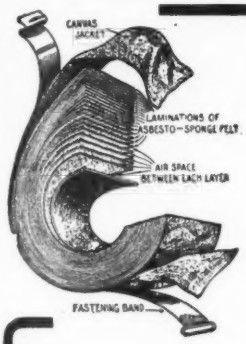

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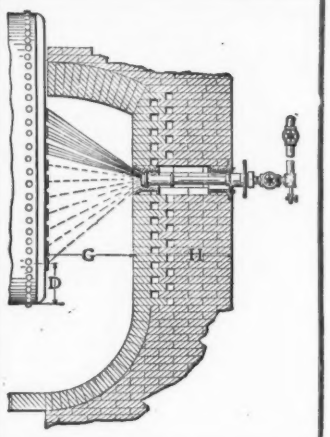

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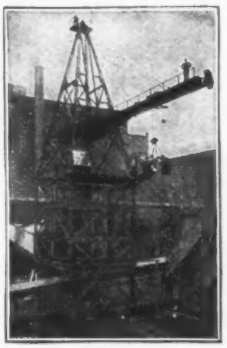

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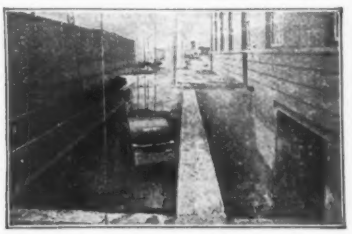

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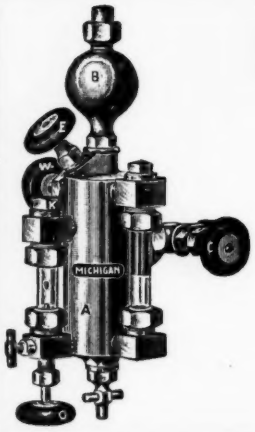

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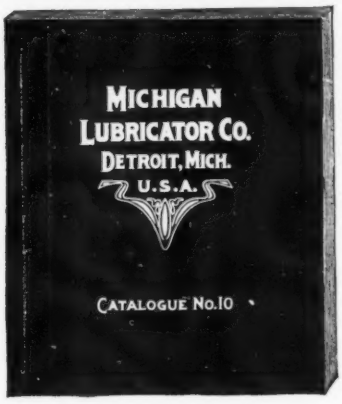

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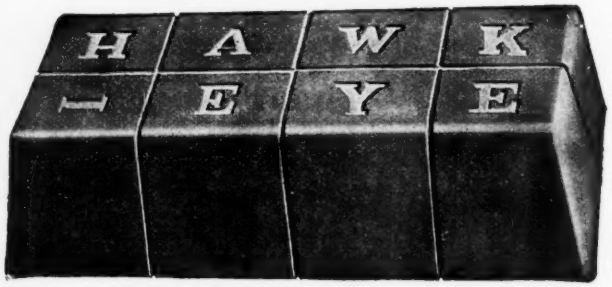

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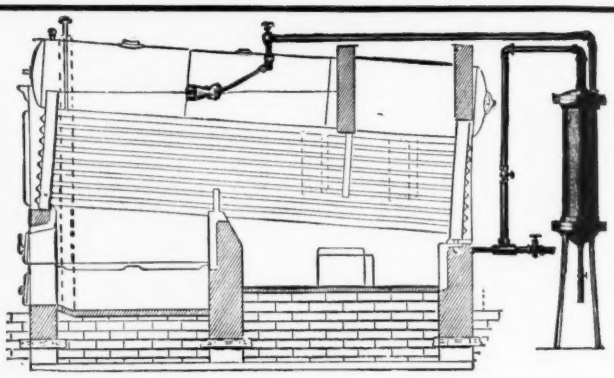

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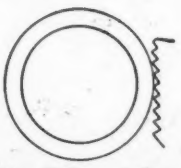
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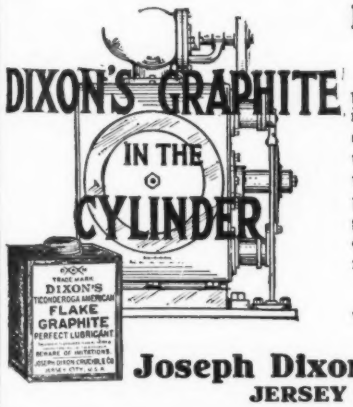

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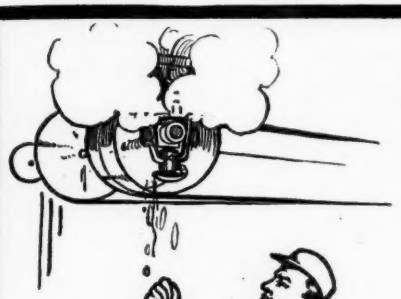

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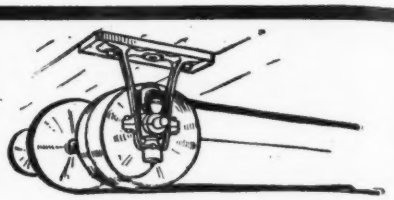

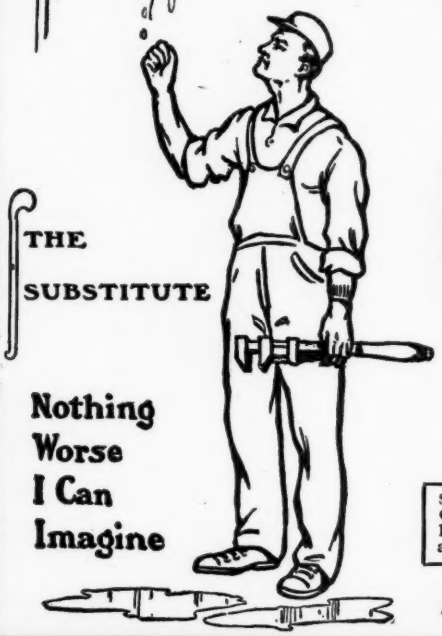

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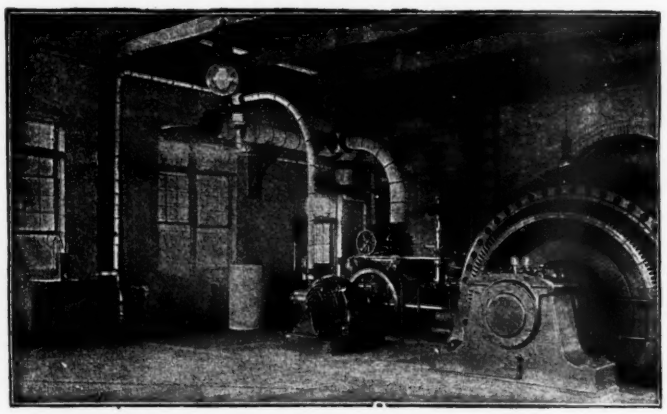

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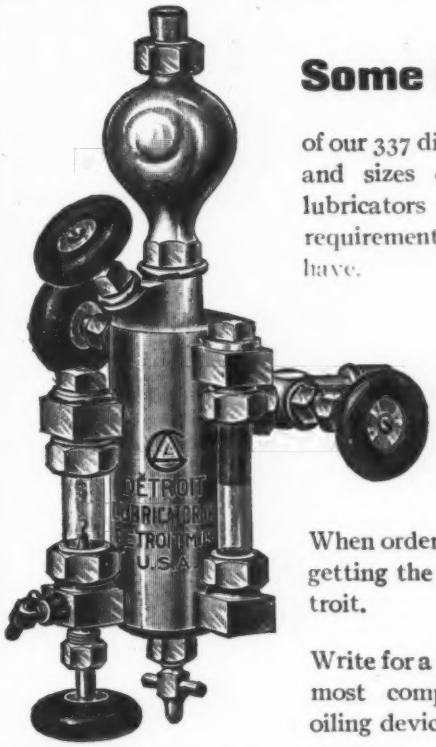

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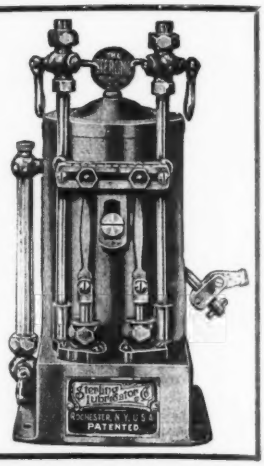

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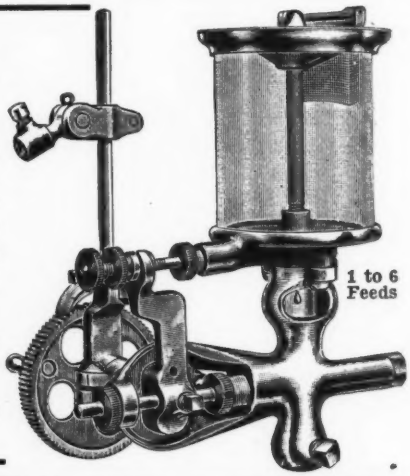

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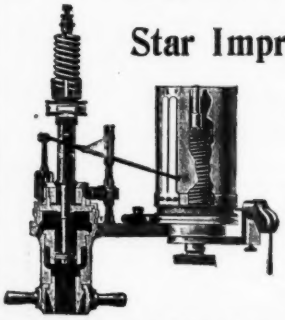

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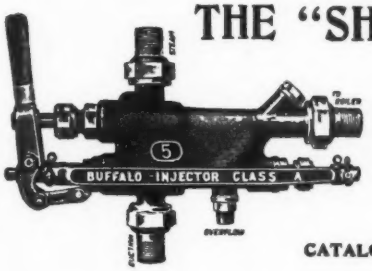

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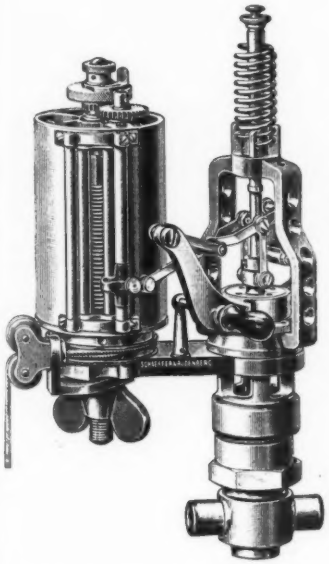

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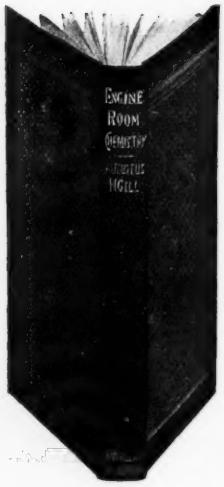

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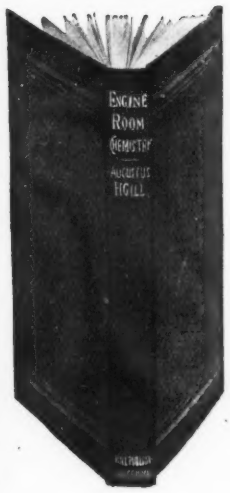

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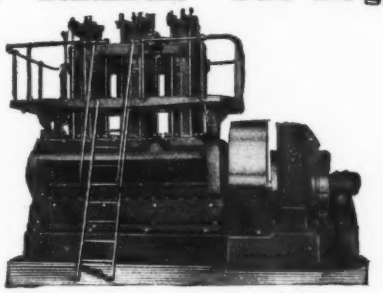

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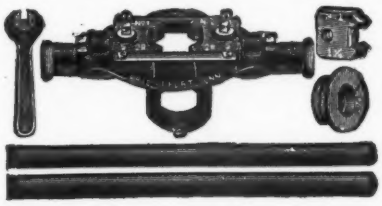

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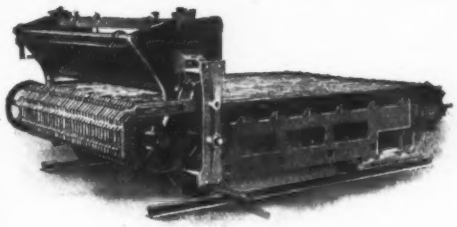

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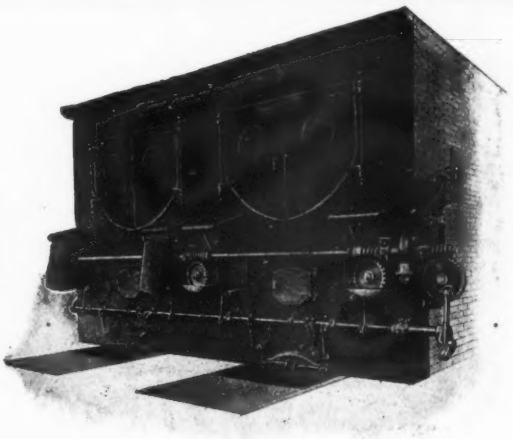

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BOILER DOOR ARCHES AND FIRE BOX BLOCKS

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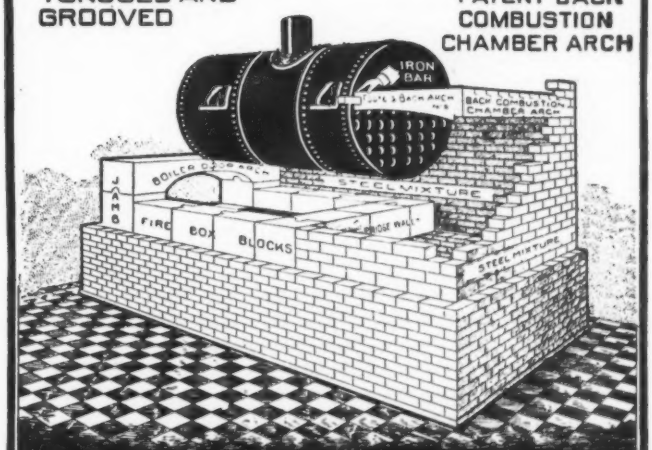
PATENT BACK COMBUSTION CHAMBER ARCH



MANUFACTURED BY
McLEOD & HENRY CO.
TROY, N.Y., U.S.A.
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

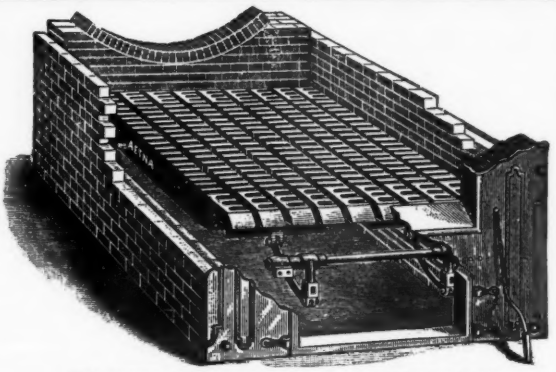
Well Begun Is Half Done.

In other words your fire grate, which is the source of your power, is really about the biggest half of your plant. Economy there saves waste everywhere.

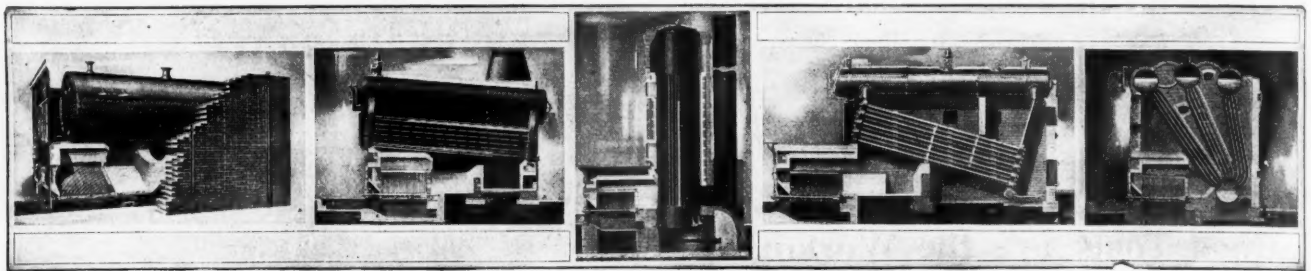
The Aetna Shaking Grate as illustrated here gives *over 60 per cent. of air space*, is easily operated and its mechanism is simple and practicable. It will burn to advantage every grade of hard and soft coal.

Write for our Grate Book.

SALAMANDER GRATE BAR CO.,
126 LIBERTY STREET, NEW YORK.
Phone, 4136 Cortlandt.



The Original Aetna Shaking Grate made for both round and square furnaces.



Any type of boiler.

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

Murphy Iron Works, 5 Walker Street, Detroit, Mich.

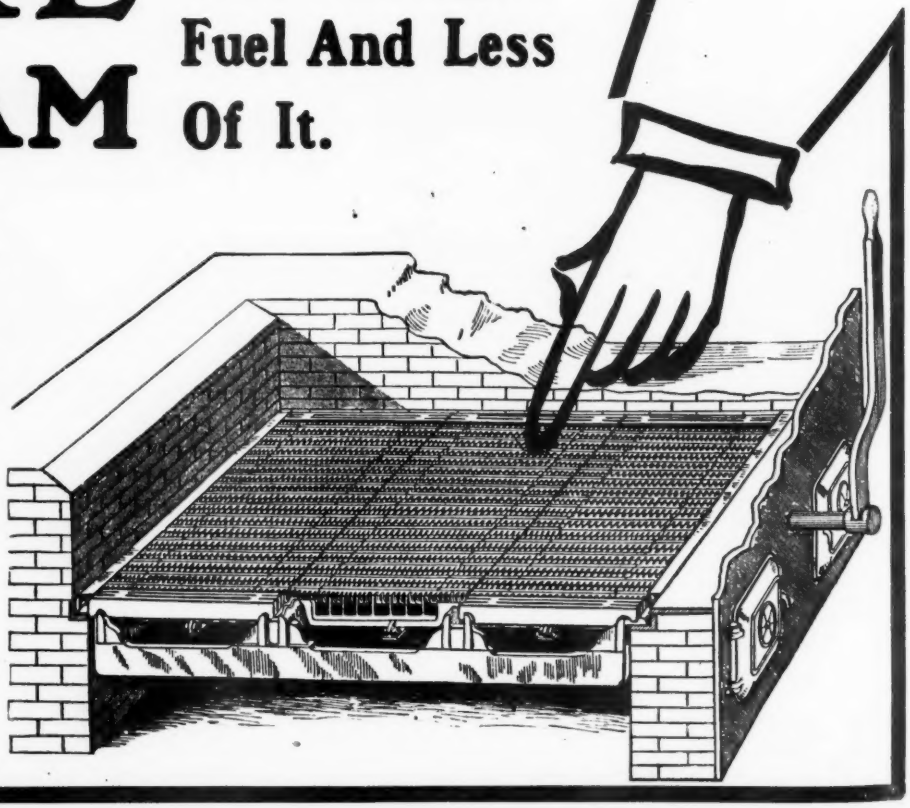
Units of any size.

MORE STEAM

With Cheaper Fuel And Less Of It.

The Martin Anti-Friction Rocking Grate burns the cheapest fuel and gives the same (or more) steam than other grates do with high-priced coal. The grate bars do not separate when working and the fire is thoroughly cleaned and loss of fine fuel is prevented.

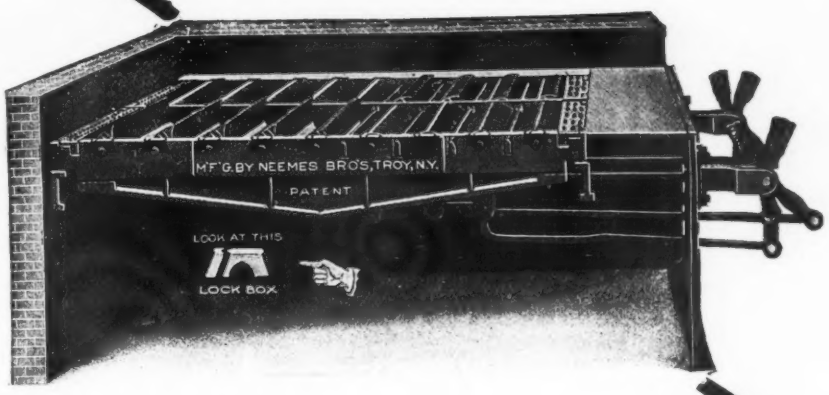
The "Martin" can be installed without alteration of the fire-box. *Write for catalog.*

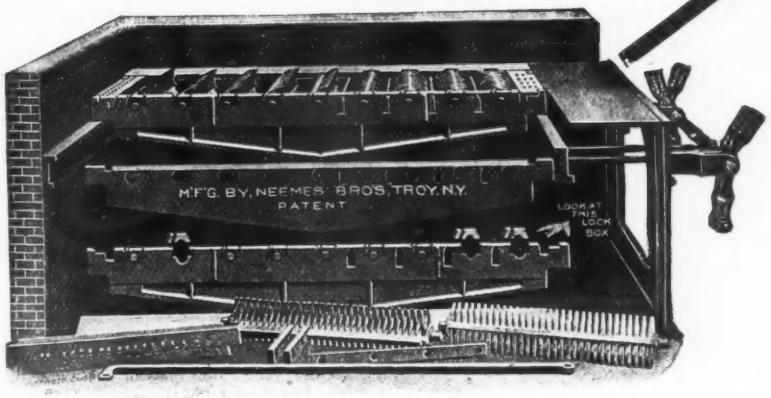


The
Martin Grate Co.
281 Dearborn St.
Chicago, Ill.

IT STANDS ALONE

As The Only Clinker Cutting, Shaking And Dumping Grate





The **Neemes Bros' Improved Grate,** Shear Cutting Shaking Grate Front and Shaking and Dumping Grate Back is the only one with which you can cut from both sides of the shaker alike. Thus more perfect combustion is secured and a cheaper grade of fuel can be burned.

Agitate the lever but slightly — and the *ashes* shake out only.

Give it a full opening and shake a few times— and the entire contents of the grate is dumped into the ash pit.

The "Neemes" saves from the start. You can operate your plant at less expense and increase your steaming capacity.

We have the proofs.

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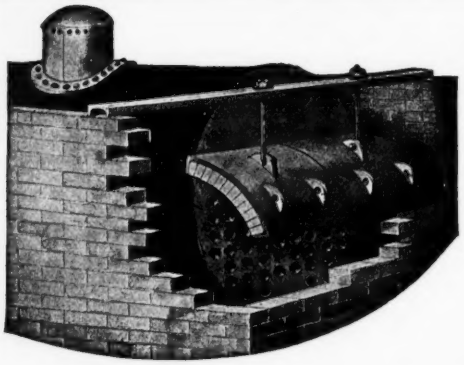
NEEMES BROTHERS, 41-49 Adams St., Troy, New York, U.S.A.

Manufacturers of Square and Round Grates.

C. W. Van Blarcom, Hudson Terminal Bldg., No. 30 Church St., Agent for New York City and vicinity. Babcock & Wilcox, Ltd., Montreal, Canada, Sole Makers for Canada. Burke Engineering Co., 311 Industrial Building, Providence, R. I., Sole Agents for the New England States. Cass Harkins, Hayden Building, Columbus, Ohio.



A Time and Trouble Saving Device

FOR RETURN FLUE BOILERS

designed to hang from above instead of resting against the brickwork. The MONARCH BOILER ARCH permits ready access to the boiler for inspection or repairs. Write for Booklet.

MAYVILLE SPECIALTY MFG. COMPANY - - - - - - MAYVILLE, WIS.

Anchored Fast

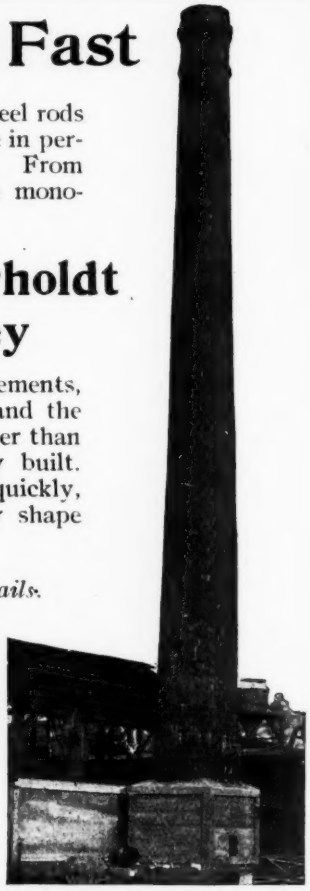
with high carbon steel rods and built of concrete in permanent tile moulds. From top to bottom, one monolithic mass.

The Wiederholdt Chimney

will withstand the elements, the heat, the gases and the ravages of time better than any other chimney built. It may be built quickly, cheaply and in any shape or size desired.

Write for full details.

Wiederholdt Construction Company
American Trust Bldg.
Chicago, Ill.



COES IMPROVED COMBUSTION AND DRAFT SYSTEM

GEO. H. THACHER & CO.,
ALBANY, N. Y.

GRATES OF ALL KINDS. BOILER CASTINGS.

We can elevate or convey your **COAL** a distance of 100 feet for less than **ONE CENT A TON**
in quantities of ONE TON A MINUTE or more.
Catalog Free.
THE C. O. BARTLETT & SNOW COMPANY,
Cleveland Ohio.

Proper Stoking Prevents Smoking

You see the truth of this in plants that use the Wilkinson Automatic Stoker and Smoke Preventer. No cloud of waste fuel pours from the stack and for every $100 worth of coal burned, from $5 to $15 is saved. What do savings like this mean to you? *Write.*

The Wilkinson Manufacturing Co.
Bridgeport, Montgomery County, Pa.

Smoke is Evidence of Wasted Fuel

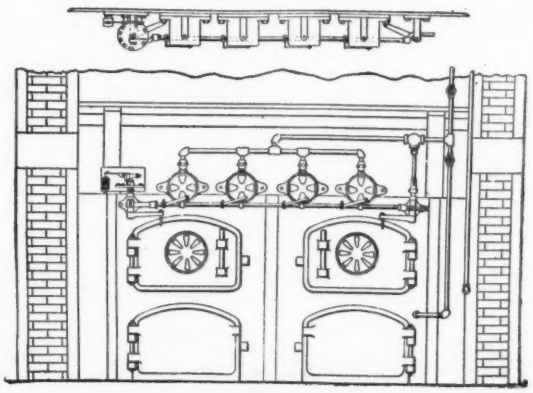
The Climax Smoke Preventer stops this fuel waste and puts an end to smoke.

We guarantee this device to produce perfect results or no pay.

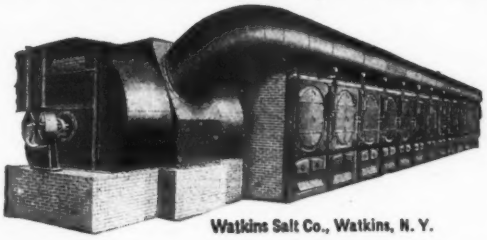
The secret of perfect combustion is a proper air supply. Our device solves this problem.

Let us hear from you.

Climax Smoke Preventer Co.,
205 Equitable Building, BOSTON, MASS.



Buffalo Mechanical Induced Draft



Watkins Salt Co., Watkins, N. Y.

Buffalo Forced Draft Apparatus

Gould's Mfg. Co., Seneca Falls, N. Y.

Mechanical draft plants are easily installed, are flexible, positive and instantaneous and provide a constant boiler pressure by automatically controlling the speed of the fan.

Complete Mechanical Draft Catalog 123-P illustrates and fully explains Induced and Forced applications of Mechanical Draft in Central Power Stations, Street Railway, Electric Light and Industrial Works.

Buffalo Forge Company
Buffalo, N. Y.

8MD

"SIROCCO"
TRADE MARK

FANS AND BLOWERS

BUILT ON THE TURBINE PRINCIPLE

SIROCCO ENGINEERING CO., 138 Cedar Street, New York

What A Draft!

Wing's Turbine Blower gives a Mechanical Draft that is absolutely independent of atmospheric conditions. *Those who use "Wing's," don't take much stock in stacks. Catalog?*

L. J. WING MFG. CO., 90 West St., Cor. Cedar, NEW YORK.

C-O-Two Furnace Tile

The best fire arch making material ever devised. Lasts longer. Increases combustion. Write for full description.

C-O-Two Furnace Co., Syracuse, N. Y.

Over 7500 Hammel Oil Burners

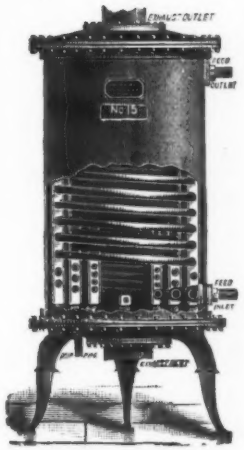
In use under Stationary Boilers, Locomotives, Kilns, Etc.

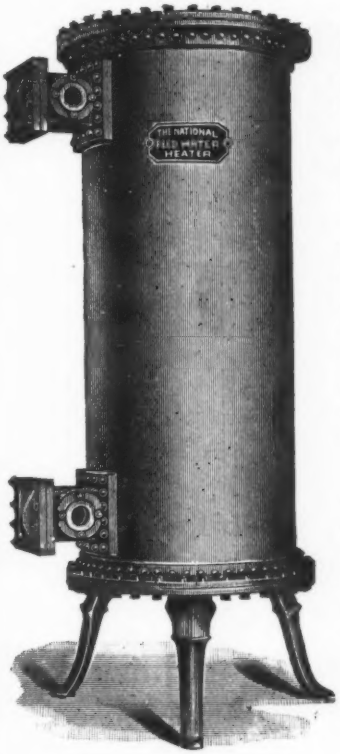
Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.

609 North Main Street, LOS ANGELES, CAL.

Don't Skip This





Interested in Feed-Water Heaters? Don't know which to buy? Claims all sound pretty much alike and heaters all look about alike to you?

Then listen!

Let's just consider National Feed-Water Heaters from a constructional point of view. Look at it in a common-sense manner.

From one to fourteen coils of seamless-drawn brass or copper tubing incased in a cast-iron or steel shell to which the exhaust steam is admitted, heating the water which passes through the coil or coils.

There you have it. That's the "National", the simplest heater made. See anything complicated about it? No inside joints or straight tubes to leak. No back pressure. No contact of the water with the shell or iron.

Here's a claim that doesn't sound like any other; a record that can't be matched. *Over 2,5000,000 H. P. in daily use.*

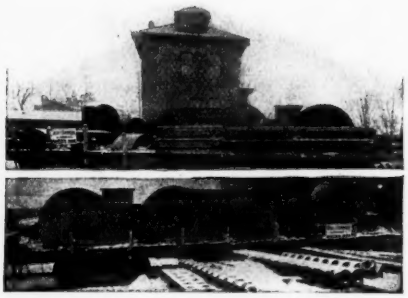
Catalog tells more.

The National Pipe Bending Co.

168 River St., New Haven, Conn.

120 Liberty Street, New York.

54 High Street, Boston, Mass.



Green Heating and Ventilating Equipment for a New York Banking House.

We show above two views of a carload of Green Ventilating Fans and Steam Heating Coils. There are five fans, 100", 90", 70", 60" and 50" sizes.

The 100" and 90" fans have double-riveted and calked, water-tight, steel bottoms, in order to keep out water from the wet foundations in which the fans are to be set. These two separate bottoms may be seen at the left in the upper picture. The fans are driven by a single motor set between them, to which they are connected through clutch couplings.

Besides the fans there are six sections of Green Straight-Pipe Heater. These heaters temper the air before it is distributed through the building. They embody several improvements over the older types of coils; for instance, the pipes are all straight and by removing the header covers, the pipes can easily be inspected or cleaned. The circulation of the steam is positive and there is no place for air binding. They may be used for live or exhaust steam or hot or cold water.

Send for our special booklet "109-P" on Heating and Ventilating, just issued.

The Green Fuel Economizer Co.
Matteawan, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines.

Sole builders of the Green Fuel Economizer in this country.

129

Every Coil a Spring

Reilly Multicoil
FEED WATER HEATER

IN AN ADVERTISEMENT we cannot describe all the advantages of this heater. We therefore ask you to write for our Catalog.

The GRISCOM SPENCER CO.
90 WEST ST., NEW YORK.

The Reilly Oil and Grease Exractor. | Agents, Russel Engines—Tudor Boilers Mfgrs: Tanks—Special Machinery of all kinds

One Square Foot To Each H. P

The heating surface being so great, it follows that the

Otis Tubular Feed Water Heater, Oil Separator and Purifer

operates with a slower circulation allowing the water to lose its impurities and thus preserve your boilers from scale.

CATALOG?

THE STEWART HEATER CO.,
50 Norfolk Ave., Buffalo, N. Y.

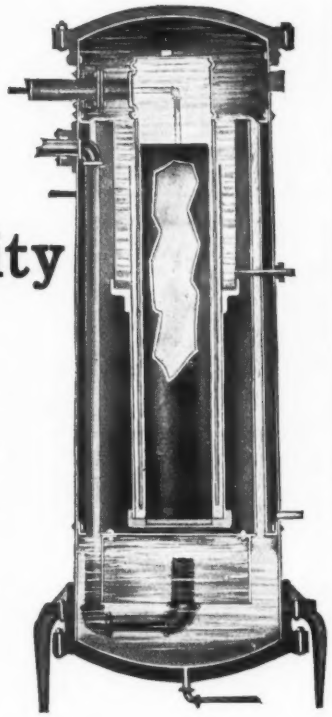
Wherever There's Polishing

to be done, U. S. Metal Polish does the work quickly and easily. It guarantees a lustre that *lasts* and *never deteriorates*. Write for free samples.

3 oz. Box, 10c. 5 lb. Pail, $1.00. 1 gal. Liquid, $1.00.
At all dealers.

GEO. W. HOFFMAN—Expert Polish Maker,
295 East Washington Street, Indianapolis, Ind.
New York City Chicago, Ill. San Francisco, Cal.

We ask Only An Opportunity



to demonstrate, in your plant, that our live steam heater is more efficient, more economical and less troublesome than any other device for heating feed water.

We will prove our claims entirely at our own expense.

WRITE TODAY.

The Eclipse Feed Water Heater and Purifier Company,

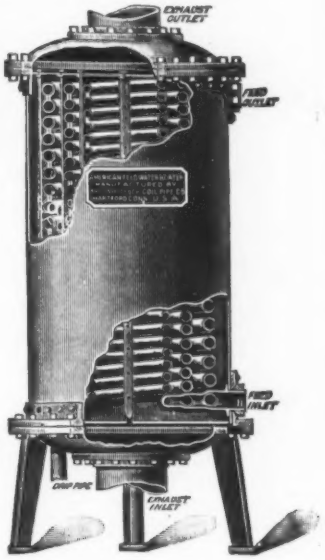
OSHKOSH, WISCONSIN

The American Standard Copper Coil Feed-Water Heater

represents the highest type of feed-water heating apparatus and should always be used where the highest temperature and most satisfactory results are desired.

It costs no more than less efficient types.

It is the simplest and most widely used type of heater in the market today.



Manufactured by

The Whitlock Coil Pipe Company

Hartford, Conn.

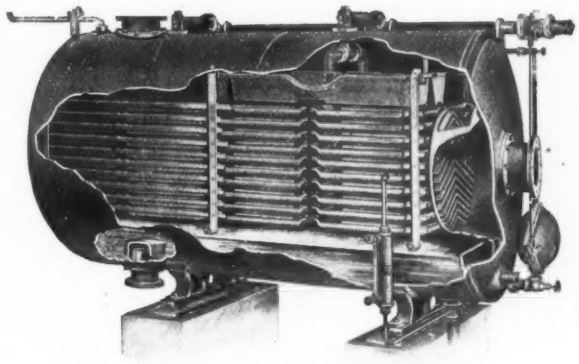
New York Office, Singer Bldg., 85 Liberty St.

DO YOU HESITATE

To Put Your Money In Bank For Fear You'll Lose It? Then Invest In A HOPPES FEED-WATER HEATER—

YOU CAN'T LOSE

Hoppes Heaters are **guaranteed** to do what any reliable feed-water heater should do—heat the water to practically boiling point and eliminate and retain all scale making solids that will crystallize at that temperature. In doing this they are bound to save the fuel pile and prevent cold water strains in boilers, both of which mean a saving of money. Therefore, Hoppes Heaters are **guaranteed to save money** for their users. **How's that for logic?** If you are skeptical, write us and we will tell you what some of our satisfied customers say.



Class "R" Cast Iron Construction Heater.

WE ALSO MANUFACTURE

Live Steam Feed-Water Purifiers, Steam Separators, Oil Eliminators and Exhaust Heads

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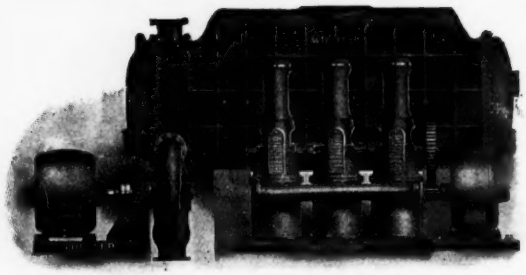
HOPPES MFG. CO. - 19 Larch St. - SPRINGFIELD, OHIO.



A Compact Condenser Outfit for a 1000-K.W. Turbine

is shown above. Its small space requirements are due to the use of the Wheeler-Edwards Patent Air Pump, which replaces a separate Dry Vacuum Pump, an Air Cooler and a Hot Well Pump, while giving as good or better results.

Power consumption is another point worth considering in electrically driven auxiliaries. A Wheeler-Edwards Pump will take considerably less current than the two pumps which it replaces. It will also cost less for driving motor, foundations, piping, valves and fittings.

As the Wheeler-Edwards Pump contains only one set of valves as against four or more sets in the separate pumps, and as the Edwards valves are always easily accessible, even when the pump is running, a Wheeler-Edwards outfit is less troublesome and more reliable than a two-pump outfit.

If it has never been explained to you why the Edwards Pump is able to accomplish perfect results in the one apparatus, send for our Bulletin "103 P," which tells how bucket and foot valves are dispensed with and how the air and vapors are allowed to flow into the pump chamber without having to overcome the resistance of valves or of water.

New York, Cincinnati, Chicago, Denver, Boston, Pittsburg, St. Louis, San Francisco, Atlanta, Houston, St. Paul.

(Builders of Wheeler Surface, Jet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heater, Wheeler Feed Water Heaters, Barnard-Wheeler Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery.) 19

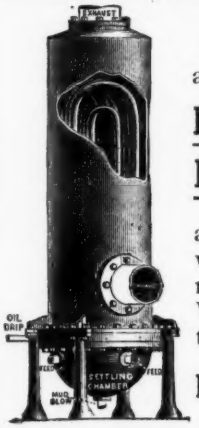
WHEELER
CONDENSER & ENGINEERING CO.
CARTERET, NEW JERSEY.

COOLING TOWERS
Fan—and Natural Draft
GEORGE J. STOCKER
St. Louis, Mo.
WRITE FOR CATALOG

Scale Cannot Form

provided you use the Advance Feed Water Purifier. To *prevent*, is better than to *remove*. Use the "Advance"—and your feed water will be clean and clear. Write for Circular No. 30.

F. E. KEYES & SON, 20 Broad St., New York



Drop The Bottom

and remove the tubes from a

Patterson-Berryman Feed Water Heater

and you have every working part within easy reach without disconnecting the large pipes.
Write for a catalog and details of the 60-day free trial offer.

Frank L. Patterson & Co.
28 Cortlandt St., New York.

Immeasurably Better

than any single shell heater because its double shell prevents radiation loss the

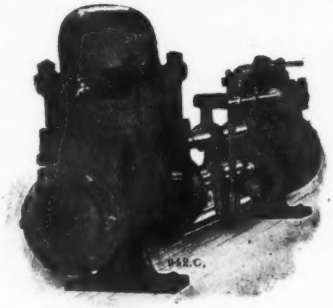
Baragwanath Steam Jacket Feed Water Heater

will heat more water for its size, heat it hotter on an equal steam consumption and require fewer repairs as well as less attention than any other device for this purpose. Write.

WM. BARAGWANATH & SON,
54 WEST DIVISION ST.
CHICAGO, ILLINOIS, U. S. A.
Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager

DEAN BROTHERS STEAM PUMP WORKS

INDIANAPOLIS, IND.

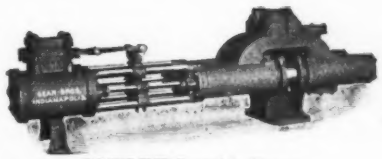


SIMPLE Boiler Feeder

JET AND SURFACE **CONDENSERS**

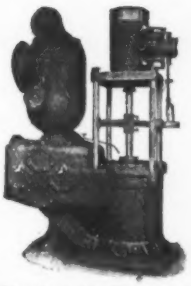
DUPLEX and SIMPLE Steam Pumps

Boiler Feeders
Fire Pumps
Electric Pumps
Vacuum Pumps
Deep Well Power Pumps

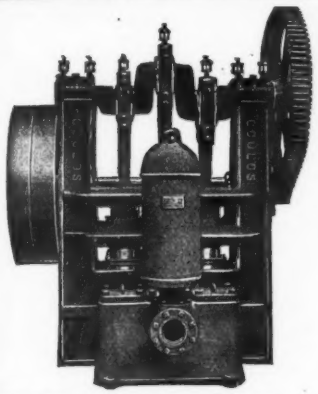


DUPLEX Durable Pump

Fly Wheel Pumps
Distillers' Pumps
Plunger Pumps
Ballast Pumps
Atlantic Type Pumps



Vertical Air Pump and Jet Condenser



GOULDS

EFFICIENT POWER PUMPS

Built in the best manner and of material that can be depended upon. They will be found to fully sustain the high reputation of

GOULDS QUALITY

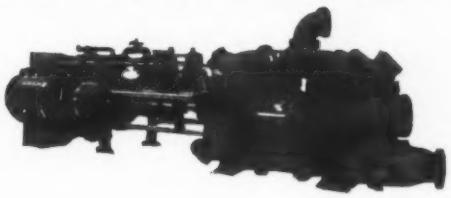
THE GOULDS MFG. CO., Seneca Falls, N. Y.

New York. Philadelphia. Pittsburg. St. Louis. New Orleans. Chicago. Los Angeles. San Francisco. Louisville.

Warren Steam Pump Co.

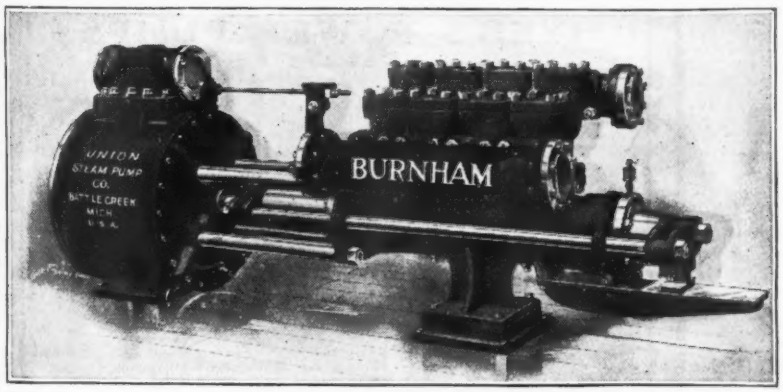
Warren, Mass.

PUMPS FOR ALL REQUIREMENTS.



Piston—Plunger—Hydraulic—Deep Well—Power.

Air Pumps and Jet Condensers, Combined Air and Circulating, and Marine. *Catalog.*



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GREAT BURNHAM Steam Pumps

WILL NOT SHORT-STROKE

Steam, belt and motor-driven to meet every requirement.

Buy a "Burnham" and Save Money

Made by the

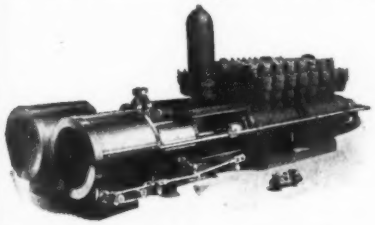
UNION STEAM PUMP CO.

Battle Creek, Mich.

PRESCOTT

50,000 H.P. Boiler Feed Pump

We also build a complete line of condensing apparatus.



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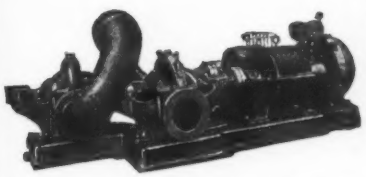
Fred. M. Prescott Steam Pump Co.

Milwaukee, Wis.

DE LAVAL



De Laval Turbine-Driven Series Pump.

Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
Steam Turbine Centrifugal Pumps
Electric-Motor Centrifugal Pumps

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DE LAVAL STEAM TURBINE CO., Trenton, N. J.

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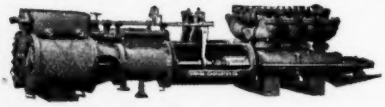

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Prevent condensation in long steam pipes.

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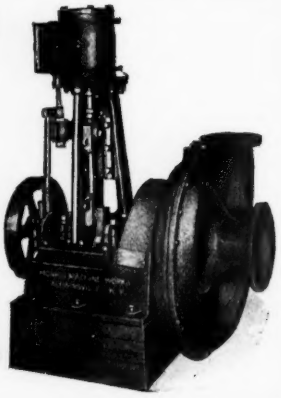
Built with a knowledge gained in 40 years of successful pump building, we make these pumps for every possible service.



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Guaranteed to form the best Vacuum by head of water or by supply pump

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In general use on all classes of engines.

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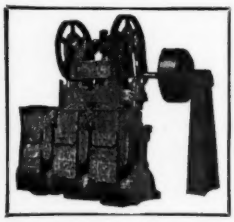

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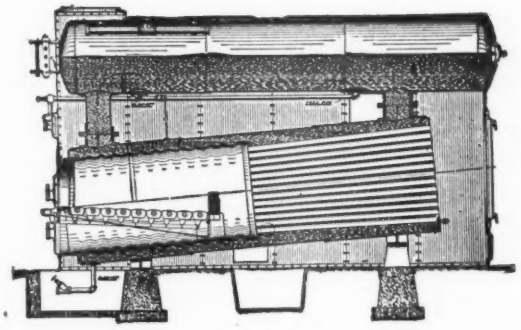

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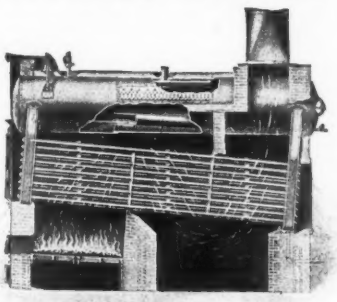

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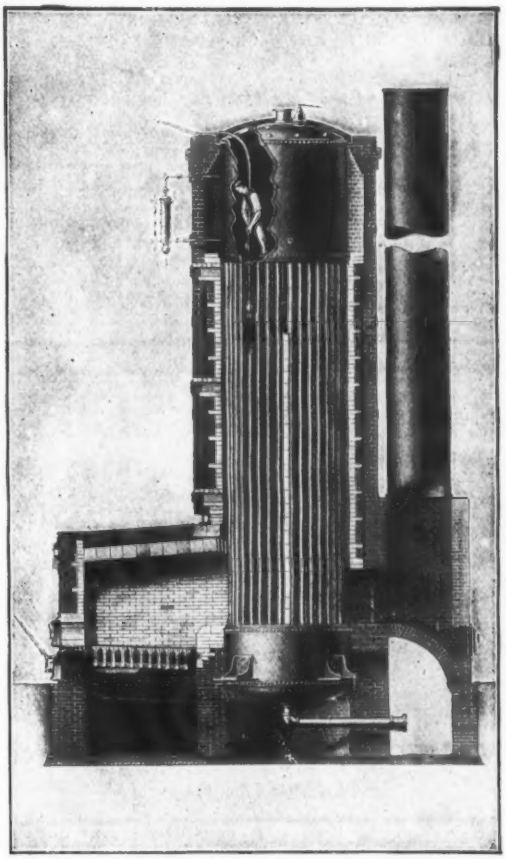
Ever cleaned a boiler? Know how hard it is? If you have you will appreciate this boiler at a glance.



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COLDEST WATER MEETS THE COLDEST GASES.
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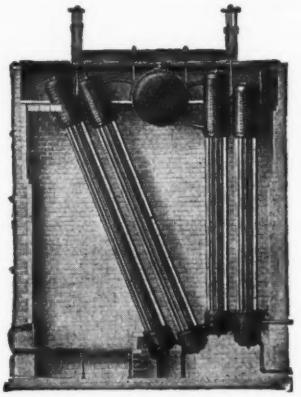

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Vulcanizers, dryers, foundry cupolas, tanks, stacks and special work.

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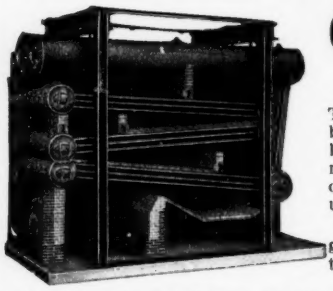

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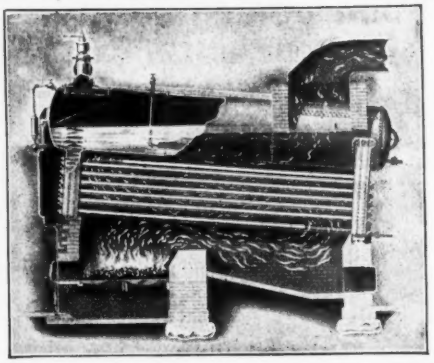

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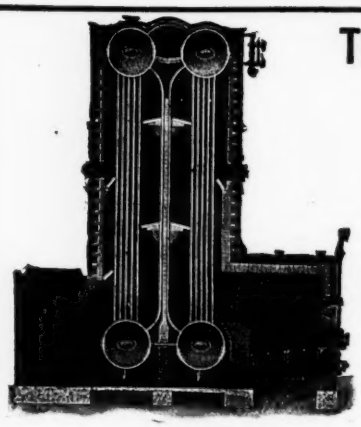

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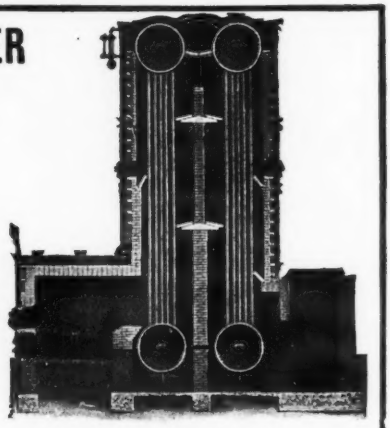

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INCORPORATED 1834

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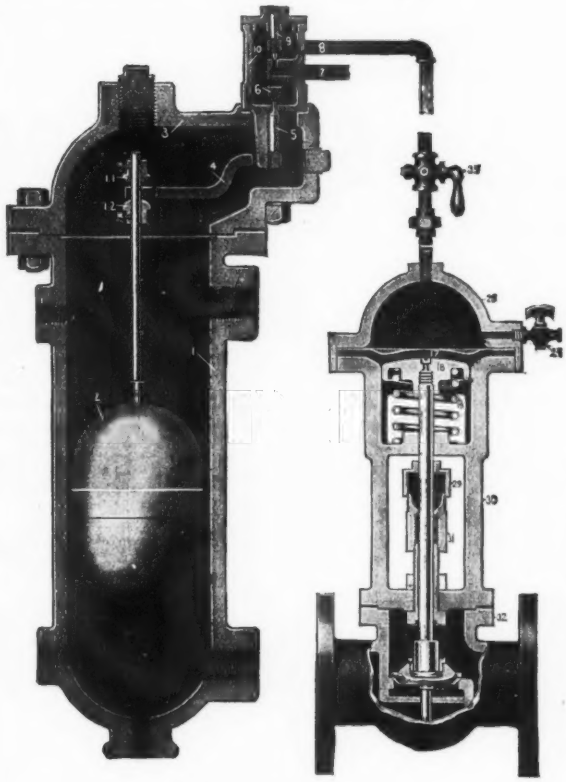
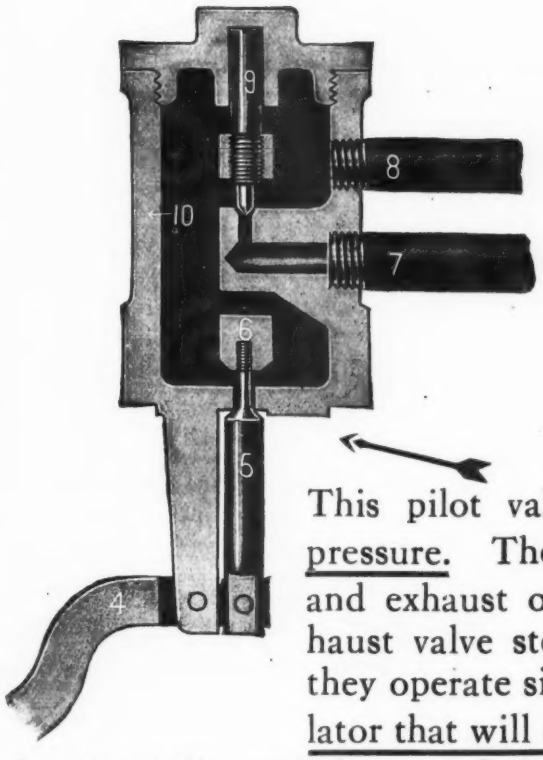
TANKS AND STEEL PLATE WORK





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FEED WATER REGULATOR

Is positive in its operation, no slide valves, gravity operated valves, thermostats or leakage valves used in its construction. The pilot, admission and exhaust valve is positively controlled by the float without depending upon gravity to close either admission or exhaust valves. These advantages are apparent to every user of feed water regulators.

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This pilot valve can be adjusted under full steam pressure. The illustration shows the admission closed and exhaust open. The admission valve stem and exhaust valve stem are constructed in such a way that they operate simultaneously. There is no other regulator that will compare with the LIBERTY in simplicity, durability and close regulation.

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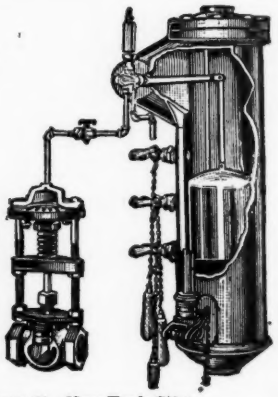
Safety
Automatic
Feed Water
REGULATOR



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depend largely upon the maintenance of a perfect pressure regulation.

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by its unfailing automatic regulation saves the engineer's time, prevents bursting mains and saves fuel.

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For maintaining an even water pressure. Should be used on all steam pumps where a fixed discharge pressure is desired. Designed right and made right, it is automatic and reliable. Send for catalogue.

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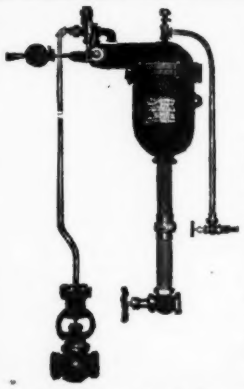

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Feed-Water Regulator

for steam boilers was the first in the *field*, and has the longest and best record of any of these devices.

Costs Less to Operate and Maintain

Constructed on a different and better principle than any other.
Investigate it and the

FULTON PUMP GOVERNOR

and send for latest catalogue with list of users.
A guarantee from a responsible firm with every machine.

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Davis Pressure Regulators Save Steam

PRESSURE
Balanced by
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That's the simple and never failing principle upon which the Davis Pressure Regulator operates. It has no springs, toggles, diaphragm or auxiliary valves in its make up.

It accomplishes its purpose—the automatic reduction of pressure—by the most direct means and enables you to use steam at any pressure less than that of the boiler for auxiliary apparatus, heating, drying, cooking or any other purpose. When once set for a certain delivery, it automatically maintains that pressure constant regardless of boiler fluctuations.

Every Davis Pressure Regulator is backed with our positive guarantee to put a check on steam waste and to prove it we'll take all the chances. It has to make good, or it's your privilege to send it back at our expense. It's all we say it is, or the trial costs you nothing.

Everything for the Automatic Regulation of pressure is shown in our general catalog. Send for it.

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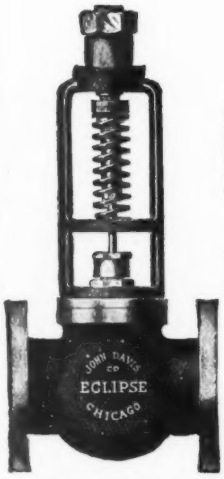
"ECLIPSE"

To show that we have implicit faith in it we will allow a thirty day trial. We have never had one come back.



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Reducing Valve.
Low Pressure Regulating Valve.
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Automatic Pump Governor.
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Distinctive points of merit in principle of construction, supported by the best of material and superior workmanship—count for the satisfactory performance of every device in use.

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In January one of our agents sold $1,500 worth;

Sales have increased every month since then.

Even men entirely inexperienced in steam plant matters have been able to secure hearings and to sell. Every steam plant can use our device and owners and engineers admit its value and merit at first sight.

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Boiler plant owners and operators buy this device when it is explained to them and afterwards they advise their friends to buy it. They are so well pleased with it that afterward they come back to the agent for other supplies. It helps the agent to build up his other business among first-class and large steam plants.

We are carrying on a vigorous advertising campaign and we supply agents with plenty of good advertising matter, catalogs, etc., with the agent's name imprinted thereon.

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Adapted for all classes of service, belted or geared. Will operate at a distance from point of control by knife-blade switch or any automatic float or pressure switch. The result of years' experience in single-phase motor building.

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Boiler inspector inside boiler "hammer-testing" the sheets

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BECAUSE the Sturtevant Fan is the most Efficient Commercial Fan in the WORLD.

BECAUSE the Sturtevant Motor is designed especially for the fan—low heat rise, great overload capacity.

BECAUSE both fan and motor are selected to save power, both are just right in size and speed.

BECAUSE the B. F. Sturtevant Co. has had 50 years' fan experience.

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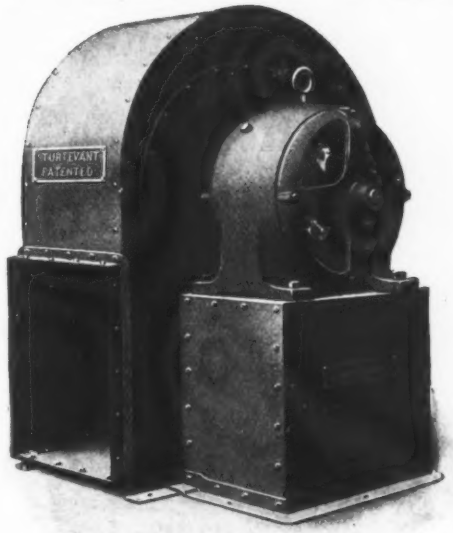

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Cruise Tube Protectors

insure you against having to install new tubes prematurely. They protect the points where the tubes are weakest. Write for particulars.

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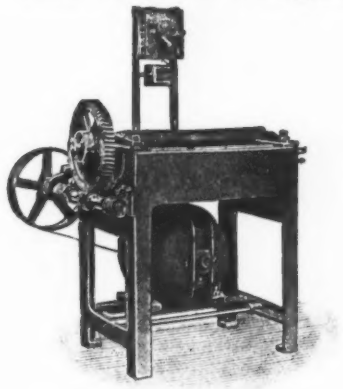
MOTORS

For Service

Let us send you our booklet "The Way to Forget"



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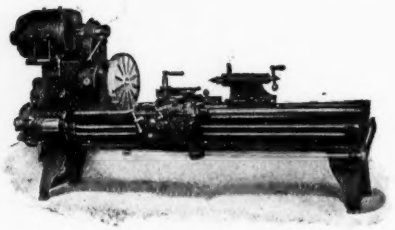
General Electric Company

Did you ever know of a shop going back to belts after using

General Electric Individual Motor Drive?



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There is no operation too small, no task too difficult to be satisfactorily and economically performed with a separate motor for each machine.

Lathes	Saws
Drills	Planers
Punches	Shapers
Shears	Millers

are a few of the machines commonly driven by

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If you are using belt drive it will pay you to investigate.

1740

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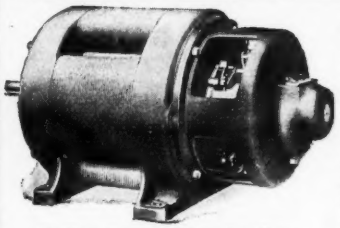
USE NORTHERN TYPE "S" MOTORS TO DRIVE POWER PLANT AUXILIARIES



Northern Type "S" Motor—Open Type. Also built enclosed.

These motors are designed to operate successfully in warm locations such as boiler rooms, etc. The unique design of the soft steel laminations, of which the field and poles are constructed, affords greater radiating surface than is possible in machines having cast frames. The laminations are so shaped as to form divided poles, resulting in perfect commutation and low temperature rise.

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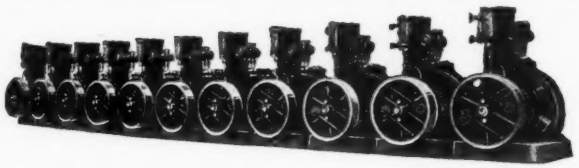
STANDARD AND SPECIAL ELECTRICAL MACHINERY
DIRECT CURRENT—ALTERNATING CURRENT.
MADISON, WISCONSIN.



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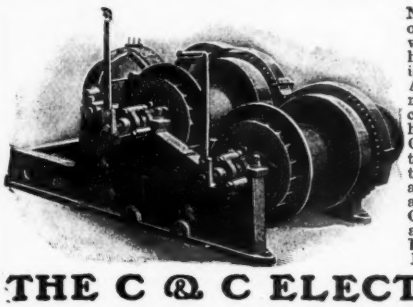
are extremely simple, compact and efficient. They may be installed to advantage especially in places where space is at a premium. Write for a circular.

Engberg's Electric & Mechanical Works,
St. Joseph, Michigan.

This Hoist is Electrically Driven by a C & C MOTOR



Notice how compact the outfit is—how out of the way the motor is, and how entirely protected it is by its casing.

At the same time this motor is perfectly accessible in every part and has the characteristic C & C merits, such as low temperature rise, capacity for heavy overloads, and freedom from noise and vibration.

Our CRANE MOTORS are just the thing for Running Skull Crackers. Try them!

THE C & C ELECTRIC CO.

General Office and Works, GARWOOD, N. J.

New York, 149 Broadway. Philadelphia, West End Trust Building.
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OVERCOME YOUR ALIGNMENT TROUBLES!

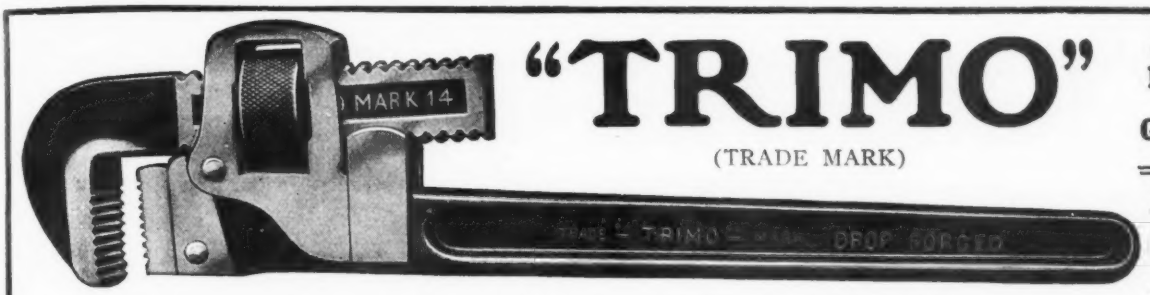
USE B-M-A FLEXIBLE LINK COUPLING

The ideal method for connecting prime movers to

GENERATORS, BLOWERS, COMPRESSORS, PUMPS, ETC.

Standard sizes up to 500 H.P., but we design them to meet all conditions and will be pleased to learn of yours.

THE BRUCE-MERIAM-ABBOTT CO.,
1688-1692 Columbus Road,
CLEVELAND, OHIO.



"TRIMO"

(TRADE MARK)

Our Past Record Is Your Guarantee

Send for our Catalog No. 21.

We want every user of Pipe Wrenches to give the "TRIMO" a trial. Superior in strength, working qualities, and ability to stand up under hard service. The Interchangeable Jaw in the handle adds 50% to the life of the wrench.

TRIMONT MANUFACTURING COMPANY, 55-71 Amory Street, ROXBURY, MASS.

GAS PRODUCERS

FOR

POWER AND FUEL GAS;

COAL GAS & WATER GAS APPARATUS.

THE GAS MACHINERY CO.,

CLEVELAND, OHIO.

208

FOOS

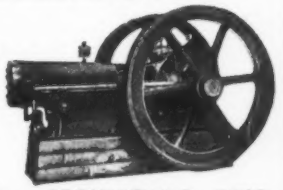
GAS AND GASOLINE **ENGINES**

HAVE WIPE SPARK IGNITER, positive acting and self cleaning.

VERTICAL VALVES, mechanically operated, admit fuel charge into cylinder at atmospheric pressure.

CENTER-LINE COUNTERBALANCING increases the efficiency and decreases the fuel bills.

ACCESSIBLE DESIGN makes it a simple matter to keep Foos Engines properly adjusted.



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THE FOOS GAS ENGINE CO., SPRINGFIELD, OHIO.

PRODUCER GAS

THE CHEAPEST POWER IN THE WORLD

GAS ENGINES, GAS PRODUCERS
COMPLETE PLANTS INSTALLED

BROOMELL, SCHMIDT & STEACY CO.,
YORK, PENNSYLVANIA.

The Loomis-Pettibone System

generates the right gas for gas engines and delivers 80% of the heat units contained in the fuel used. The gas is free from tar. Here is real

Economy and Efficiency

Write for Catalogue "Type C"

Power & Mining Machinery Co.

New York Office
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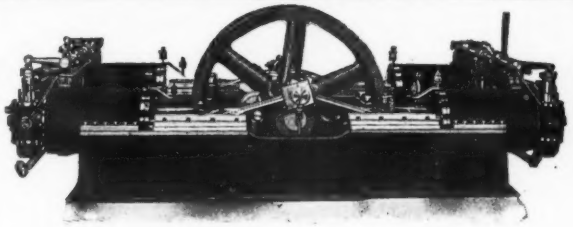
Milwaukee, Wis.



For Heavy Duty

the Miller Gas Engine will easily prove itself superior to any other internal combustion engine on the market. It is built in 35, 50, 75, 100, 150 and 250 Horse Power sizes. Every part is designed with a view to strength, reliability and durability. The result is a harmonious combination of efficiency and economy. Catalog on request; write for it to-day.

THE MILLER IMPROVED GAS ENGINE CO.
SPRINGFIELD, OHIO, U. S. A.

OTTO ENGINES

OTTO OTTO

Otto Suction Gas Producers and

OTTO ENGINES are reliable and can be operated by men of ordinary intelligence.

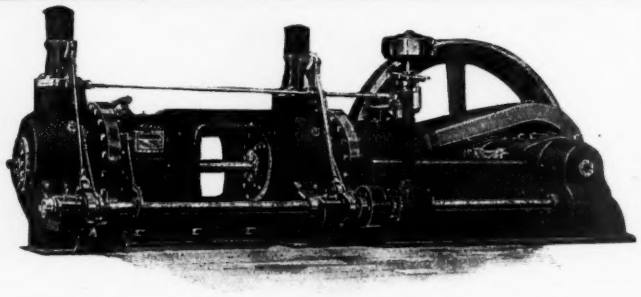
J. A. Witter, Engineer for the Beaver Crossing Electric Light & Power Co., Beaver Crossing, Neb., writes:—

"Please send me a book of instructions on handling and running your gas producer and engine. I have been running this one on horse sense but that might not work at all times. Plant works fine."

This man, without special instructions but with the use of "horse sense" causes his plant to work fine. There is a volume of praise for "OTTO" machinery in Mr Witter's short letter.

The Otto Gas Engine Works,
Philadelphia, Pa.

STANDARD OF THE WORLD



WARREN GAS ENGINES
AND
SUCTION GAS PRODUCERS

SATISFACTORY AND CONTINUOUS SERVICE
REGULATION AND ECONOMY GUARANTEED

WORKING PARTS
FEW IN NUMBER
EASY OF ACCESS

ENGINES OF VERTICAL AND HORIZONTAL TYPES
75,000 HORSE POWER IN SUCCESSFUL OPERATION

STRUTHERS-WELLS COMPANY, - - - Warren, Penna.

THE ESSENTIALS FOR A PRACTICAL AND DURABLE GAS ENGINE

are simplicity of design, perfection of construction, absolute governor control, which means economy of fuel and sufficient weight to withstand the continuous high pressure of explosions to which they are subjected.

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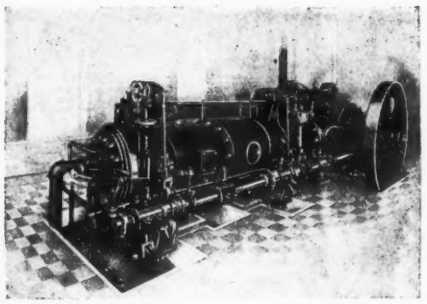
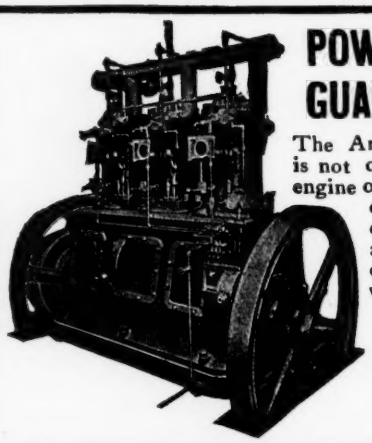


DUBOIS IRON WORKS ESTABLISHED 1877
805 BRADY STREET, DUBOIS, PA.



POWER COSTS GUARANTEED

The American Diesel Engine is not only the most efficient engine on earth but it burns the cheapest liquid fuel—crude oil. We can guarantee a cost which no other engine can develop under test.

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AMERICAN DIESEL ENGINE CO.
11 Broadway, N. Y.

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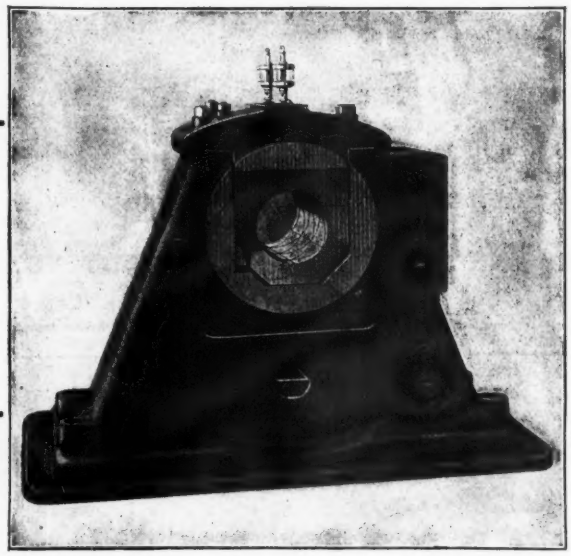
Drives

PUMPS
GENERATORS
BLOWERS

Write for bulletin describing our direct connected units.

KERR TURBINE CO
WELLSVILLE, N. Y.

Rollins Pillow Block



The pillow block is so designed that the bracing effect of the walls extends to the very top. The foundation is very broad and liberal weight and strength are evident in every line.

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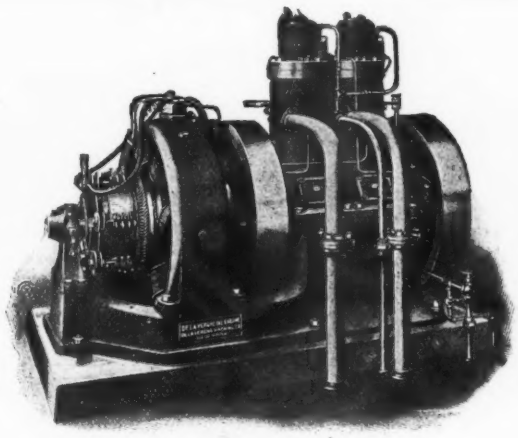
29 MASON STREET, NASHUA, N. H.
Pacific Coast Representatives
ARMSTRONG-KRELING MACHINERY CO., San Francisco, Cal.



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OIL ENGINES

are cheaper, simpler. more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

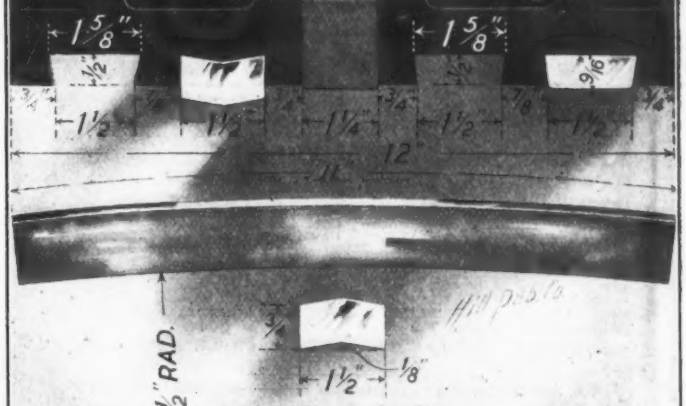
5315 H.P. used by Baldwin Locomotive Works

The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
"Hornsby-Akroyd" Horizontal Four-Cycle 2 1-2 to 250 H. P.

DE LA VERGNE MACHINE CO.

Foot East 138th Street, NEW YORK.

Allan Metal Faced
High and Low Pressure Pistons
Keep the cylinder in a smooth and polished condition.
Overcome excessive wear.
Cannot under any condition score the cylinder.
Write for our Booklet
The Heart of the Engine
The Seat of Power.



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Inventors and Sole Manufacturers
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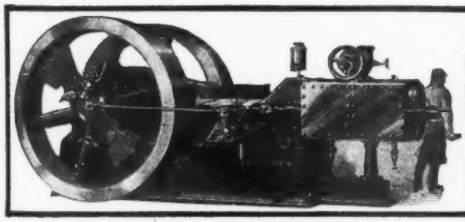

Good Engines
for every power purpose. Ask for Catalog.
Watertown Engine Co.,
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We Manufacture
AN ECONOMICAL AND DURABLE ROTARY ENGINE
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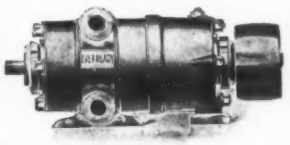

Ball-Cooley Engineering Co.
316 HUDSON ST., NEW YORK CITY and 159 GREEN ST., BOSTON.

ALBERGER TANDEM GAS ENGINES
ACCURATE REGULATION FOR ELECTRIC SERVICE-AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR
A.H.ALBERGER COMPANY
45 TO 600 H.P. USING NATURAL GAS
35 TO 500 H.P. USING PRODUCER GAS
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FOR SALE

One 50 H. P. Tandem Cylinder Gas Engine little used, at a bargain. Also 3 or 4—25, and 30 H. P. Gas Engines at a reduced price. Good as new.

Ajax Iron Works, Corry, Pa.

We Save Delays

and a delay of one day is often many times more costly than the work in hand. In addition to our saving in this direction we save express and freight charges, etc.

AMMONIA CYLINDERS INDICATED

"Useful Hints P" Sent to Engineers upon Request.

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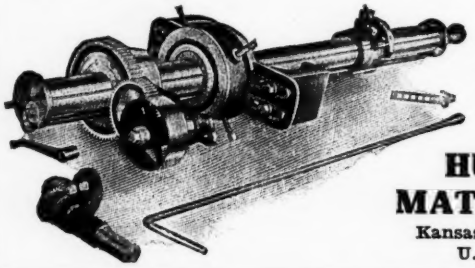
Established 1870
1021 Hamilton St., PHILADELPHIA, PA., U.S.A.

Rebore Your Own Cylinders

You can do it easily and quickly with our Portable Boring Bar while the cylinders are in position. See the saving?



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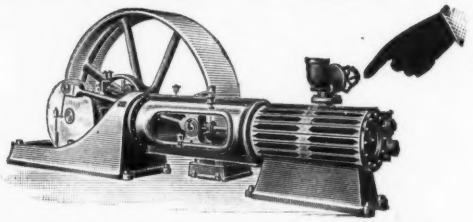
HUGH MATHEWS
Kansas City, Mo.
U. S. A.

Fitchburg Engines



Guaranteed steam tight for 25 years on one hour's work per year. *Write.*

FITCHBURG STEAM ENGINE CO.; - FITCHBURG, MASS.

E. H. Ludeman & Co., 165 Broadway, New York. H. J. Gebhardt, 1419 Fisher Bldg., Chicago. Geo H. Connor, 509 Mutual Life Bldg., Philadelphia, Pa. W. C. Teas, Chattanooga, Tenn. Western Trading Co., San Francisco.

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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
18 x 42 Hamilton Corliss	14 x 24 Atlas, Automatic
18 x 36 Wright, Corliss	13½ x 15 Taylor, Automatic
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12 x 24 Wetherill, Corliss	12 x 14 Green, Automatic
10 x 30 Hamilton, Corliss	12 x 12 N. Y. Safety, Automatic

Also large assortment of Automatic and Throttling Engines of other sizes.

BOILERS

84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.

Write for bargain list.

We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

THE RANDLE MACHINERY CO.
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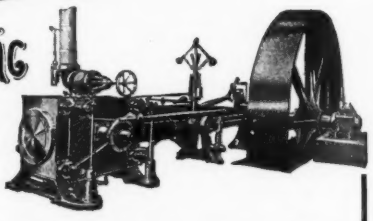
THE IMPROVED FISHKILL CORLISS ENGINE

BUILT BY THE FISHKILL LANDING MACHINE CO., FISHKILL ON THE HUDSON, N.Y.



The most efficient and economical power for all purposes.

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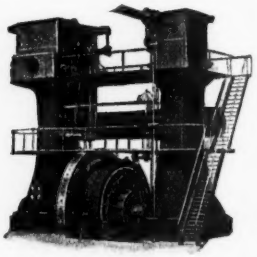
HEAVY DUTY CORLISS AND Piston Valve Engines



Mesta Machine Company
Pittsburgh

Lammert & Mann

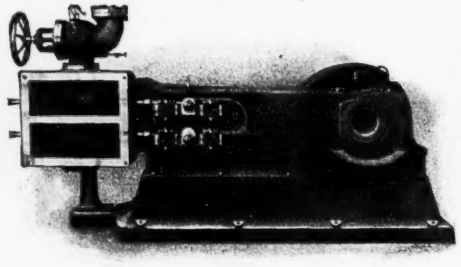
Engineers and Machinists

157 S. Jefferson Street, CHICAGO

WE MAKE A SPECIALTY OF

Corliss Engine Repairs. Engines Indicated.
General Jobbing. Repairing Engines.
Pumps, etc., all kinds Special Machinery.
Pulleys, Hangers, Shafting, etc. Oil Dash Pots.

Very Short Direct Ports



reduce the friction to the passage of steam. The high economy of Chuse Engines is largely due to this design of the ports.

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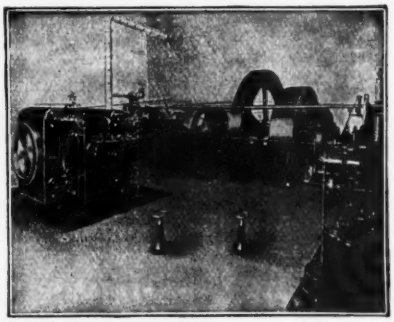
Chuse Engine & Mfg. Company
MATTOON, ILL.

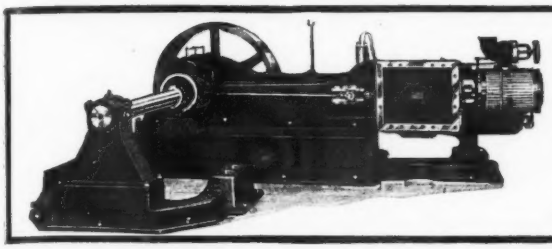
Complete Power Plants.



The VILTER Mfg. Co.
854-894 Clinton St.
MILWAUKEE, WIS.

CORLISS ENGINES

ICE MACHINES



Skinner Engines

have set a new mark for maintained economy, close regulation and perfection of lubrication.

SKINNER ENGINE CO., - ERIE, PA.

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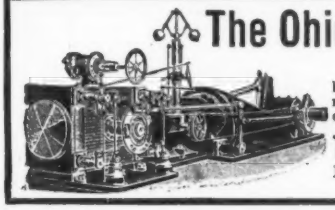
Simple, condensing and compound, 50 H. P. to 2000 H. P. Complete steam power outfits for every service, Superior in workmanship and performance.

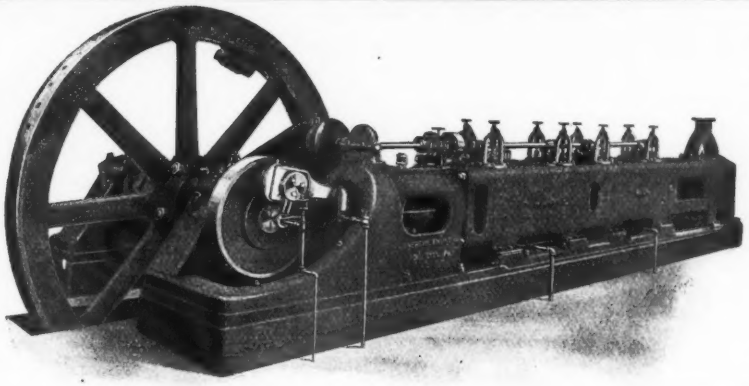
THE BASS FOUNDRY & MACHINE COMPANY,
FORT WAYNE, INDIANA.

The Ohio Corliss Engine



For hard work, heavy loads and high-speed, the Ohio shows close regulation and runs smoothly and quietly.

THE GRIFFITH & WEDGE CO.
Est. 1840. ZANESVILLE, OHIO



Riverside Heavy Duty Gas Driven Air or Gas Compressor (Class F)

Not Made From Wash Drawings

The cuts we show are made from engines we have built and delivered to purchaser, and they are giving steam engine satisfaction at a fraction of the cost, some of them in twenty-four hours' service. The RIVERSIDE heavy duty gas engine, is wholly unlike any other and is built in twelve types and seventy-two sizes from 10 to 2500 H.P.

We also Build a Complete Line of Gas Driven Air and Gas Compressors

Riverside Engine Co., Oil City, Pa.

New York City, 50 Church St. Pittsburg, Keenan Bldg. Cleveland Holbeck Co., 924 Rockefeller Bldg. Fitchburg, Mass., The Brown-Russell Co. Atlanta, The W. E. Austin Co., Candler Bldg. Philadelphia, W. P. Dallett, 49 No. 7th St. Indianapolis, Mr. F. Louis Egan 1139 Congress Ave.

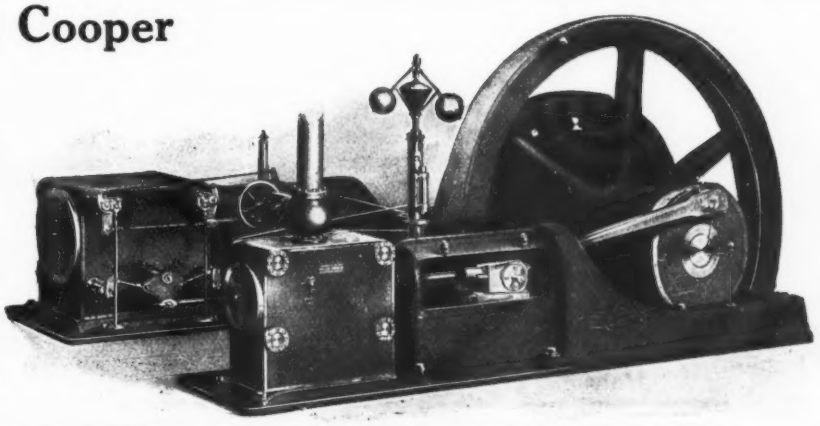
Fine Results From Cooper Corliss Engines

are being secured in all classes of service. We are Engine Builders and also do Complete Steam Plant Engineering.

THE C. & G. COOPER CO.
Mt. Vernon, Ohio.

BRANCH OFFICES:

New York, 918 Bowling Green Bldg.; Boston, 411 Weld Bldg.; Pittsburg, 604 Frick Bldg.; Philadelphia, Drexel Bldg. Atlanta, 310 Candler Bldg.; Charlotte, N. C., Court House Square; Chicago, 1539 First Nat'l Bank Building.



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ENGINES

VERTICAL, HORIZONTAL.

BELTED, DIRECT COUPLED.

Simple, Compound. Triple Expansion.

New York:
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BUCKEYE ENGINE COMPANY,

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BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION

AND

ABSOLUTELY RELIABLE

CORRESPOND WITH US BEFORE PURCHASING

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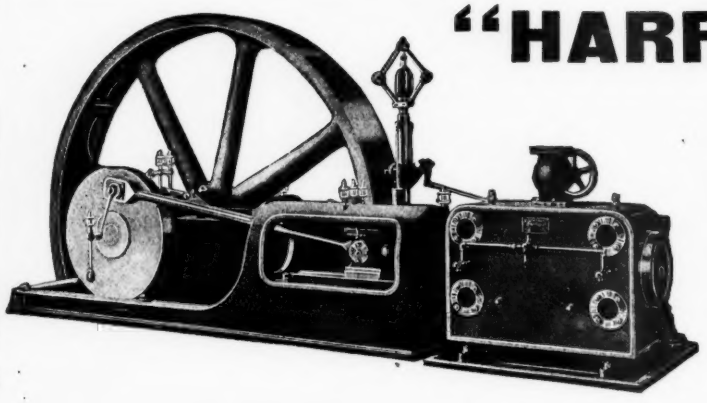
"HARRIS-CORLISS"



Remember this name ! It has been handed down since 1864 and stands for the best Corliss Engine on the market—bar none. Among its many valuable features is the BROWN PATENT RELEASE GEAR, a quick and positive mechanism found only on "Harris-Corliss" Engines. It guarantees the *closest regulation* and *greatest efficiency.*

Write for details and specifications

WM. A. HARRIS STEAM ENGINE CO.,
PROVIDENCE, R. I.

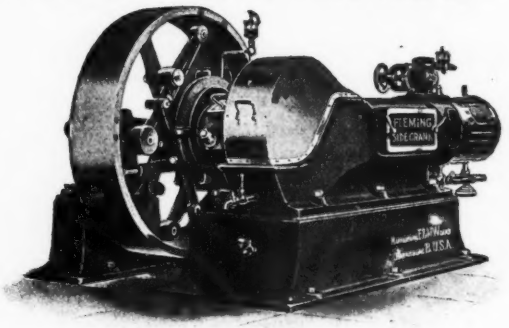
FLEMING-HARRISBURG ENGINES

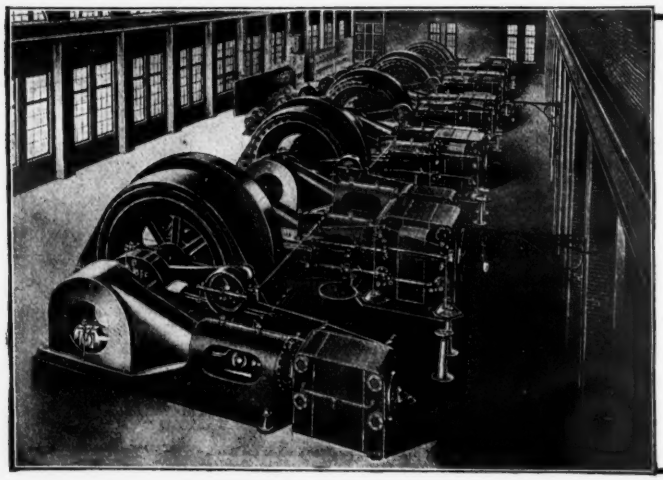
are known the world over for their satisfactory and economical operation in all kinds of diversified service—built

Simple, Tandem and Cross Compound
in both **Single and 4-Valve Types**

Harrisburg Foundry and Machine Works,
Harrisburg, Pa., U. S. A.

Selling Offices in all principal cities.





Rice & Sargent Corliss Engines

ARE NOTED FOR

Reliability, Economy, Overload Capacity and Speeds Higher than Other Corliss Types.

RESULT—Lowest Final Cost of Power

The illustration shows RICE & SARGENT engines operating Alternating Current Generators in Parallel at 100 R.P.M.

The maximum capacity of the plant shown is 12000 H.P.

DESIGNED AND BUILT BY

PROVIDENCE ENGINEERING WORKS

Main Office and Works **PROVIDENCE, R. I.**

CORLISS ENGINES.

Simple, Tandem and Cross Compound

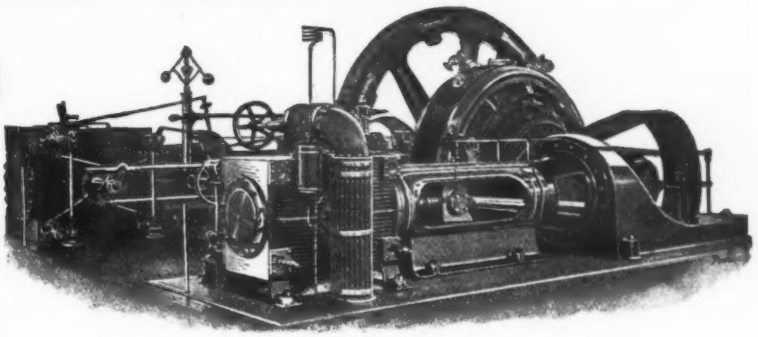
From 50 to 3000 H. P.

Heavy Duty or Girder Frame.

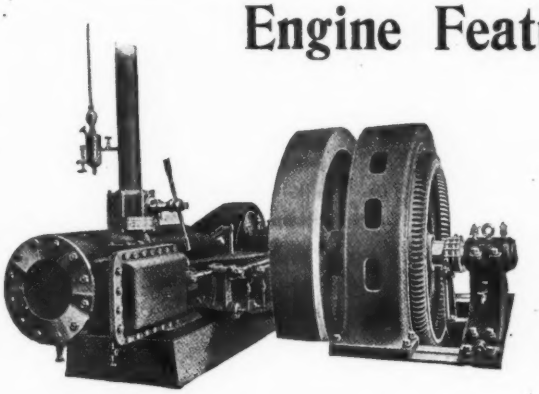
ST. LOUIS IRON and MACHINE WORKS,

Main Office and Works, St. Louis, Mo.

New York Office, 135 Broadway.



Engine Features Of Exclusive Excellence



The Clark Heavy Duty Double Valve Automatic Engine has valves whose travel is unvarying and valve seats are, therefore, always tight. It has bored guides; steel cross heads; a perfect governor, etc. All the features combine to attain unequalled steam economy, regulation, freedom from repairs, and a long life of highest efficiency.

The Clark Bros. Company,

Belmont, N. Y., U. S. A.

Do you want a high duty air pump that won't stop? Made in two styles—single, for engine work—two stage, for turbine work.

The air pump is operated by a Corliss engine with variable speed control. Engine and air pump both accessible for cleaning and adjustment without taking down.

New Corliss Engines for Immediate Delivery		Corliss Engines for 30 Days Delivery	
1 10x24,	60 H. P.	2 10x24,	60 H. P.
2 12x30	75 "	1 12x30,	75 "
1 14x36,	115 "	2 14x30,	100 "
1 16x30,	126 "	1 16x30,	126 "
1 16x36,	150 "	1 16x36,	150 "
1 18x42,	200 "	1 18x36,	190 "

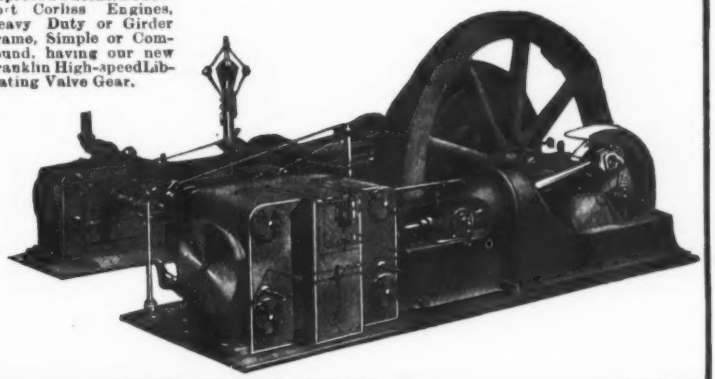
Second hand Engines.

One 16x36 Corliss Engine, 150 H. P., capacity, in first class order, for immediate delivery.

One 12x28 Corliss Engine, 75 H. P., in first class order, for immediate delivery.

HEWES & PHILLIPS IRON WORKS, NEWARK, N. J.

Improved Patent, Double Port Corliss Engines, Heavy Duty or Girder Frame, Simple or Compound, having our new Franklin High-speed Liberating Valve Gear.



"ERIECO"

The engine that even under the most severe conditions operates without noise, excessive heating or distress to any part.

CATALOG?

Erie Mfg. & Supply Co.

1203 Peach St., Erie, Pa.

The Engine For Hotels, Office Buildings And Hospitals

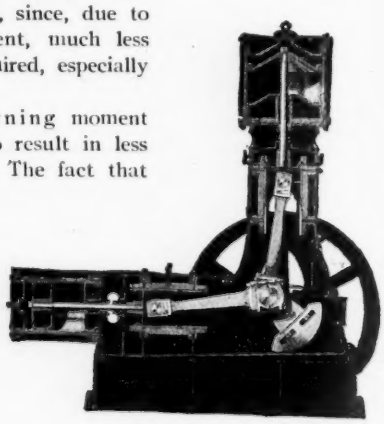
SUPPOSE a giant were to bounce a two- or three-ton rubber ball up and down in the basement of your building at a rate of 250 times a minute. Would you notice any vibration on the upper floors? A similar thing occurs when you install, say, a single-cylinder 160-H.P. electric-light engine and run it at the same speed.

The best that can be done to balance a single-cylinder engine is but a poor compromise. With no counterweight there is a powerful tendency to shift the engine to and fro upon the foundations. If the reciprocating parts are completely balanced, equal unbalanced forces are created in a vertical direction that have an effect upon the engine foundations similar to that produced by the bounding of the two-ton rubber ball. The engine designer usually takes the middle course—that is, puts on a counterweight about half heavy enough to counterbalance the reciprocating parts, so that instead of a two-ton rubber ball you have a one-ton ball.

We offer you an engine that has no unbalanced forces whatever, that can in fact be set upon a light foundation, such as second-story concrete floors, without bolting down, and can then be run at full speed without producing the least tremor.

Such an engine is the **American-Ball Angle Compound,** which has two cylinders set at right-angles so that the resultant of the forces produced by the reciprocating parts can be exactly balanced in all positions by a single counterbalance. This arrangement results furthermore in a marked saving of room. There is likewise a saving in weight, since, due to the even turning moment, much less flywheel capacity is required, especially for driving alternators.

The more even turning moment and lighter flywheel also result in less wear on the bearings. The fact that the engine is compounded reduces the steam consumption by 25 per cent. as compared with a single-cylinder engine.



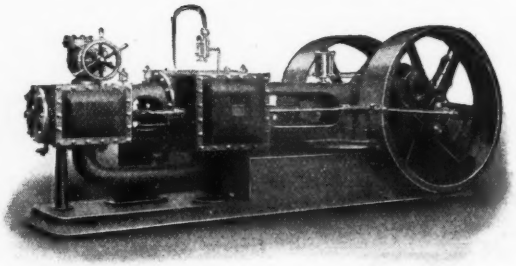
Before finishing the plans of your engine room get Bulletin No. 14

The American Engine Co.

22 Raritan Ave., Bound Brook, N. J.

11

If You Are An Expert Engineer

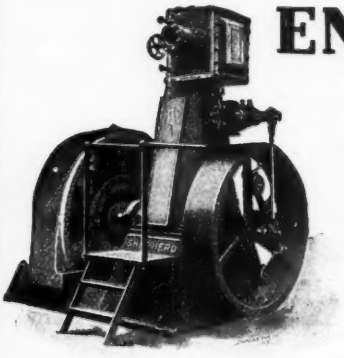


you need the Ridgway Engine because your time is too valuable to be wasted fooling with engines of the trouble-making kind.

If you are not expert you need the Ridgway because, having no parts that get out of order, it makes but slight demands on the engineer's ability. Write.

RIDGWAY DYNAMO & ENGINE CO.,
Works—Ridgway, Pa., U. S. A.

SHEPHERD ENGINES



are *not* the *cheapest* engines per rated h.p. on the market; but, contradictory as it may seem, they *are* the *least expensive.* For, in considering engine expense, the first cost is not the most important feature.

It's the *economy of operation,* the *freedom from repair bills,* the *sure, safe service* yielded by

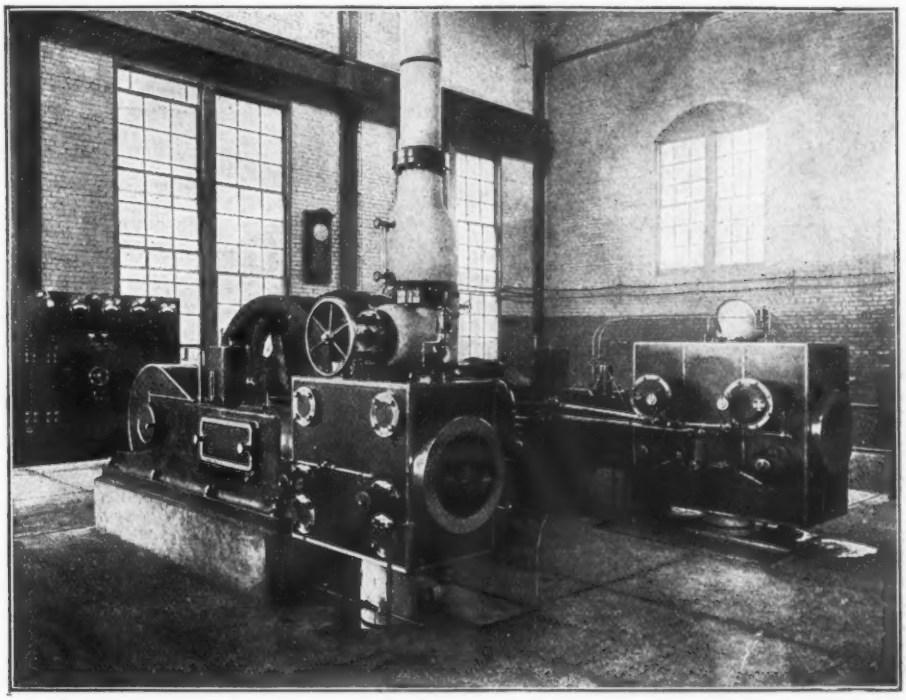
Shepherd Engines

in the after years that made them, of all known engines, the *least expensive.*

Ask the man who has one.

SHEPHERD ENGINEERING CO.
Williamsport, Pa.

THE BALL ENGINE CO., ERIE, PA.



Cross Compound Non-Releasing Valve Gear Corliss Engine
Direct Connected to Generator, in Dean Electric Co. Plant, Elyria, Ohio.

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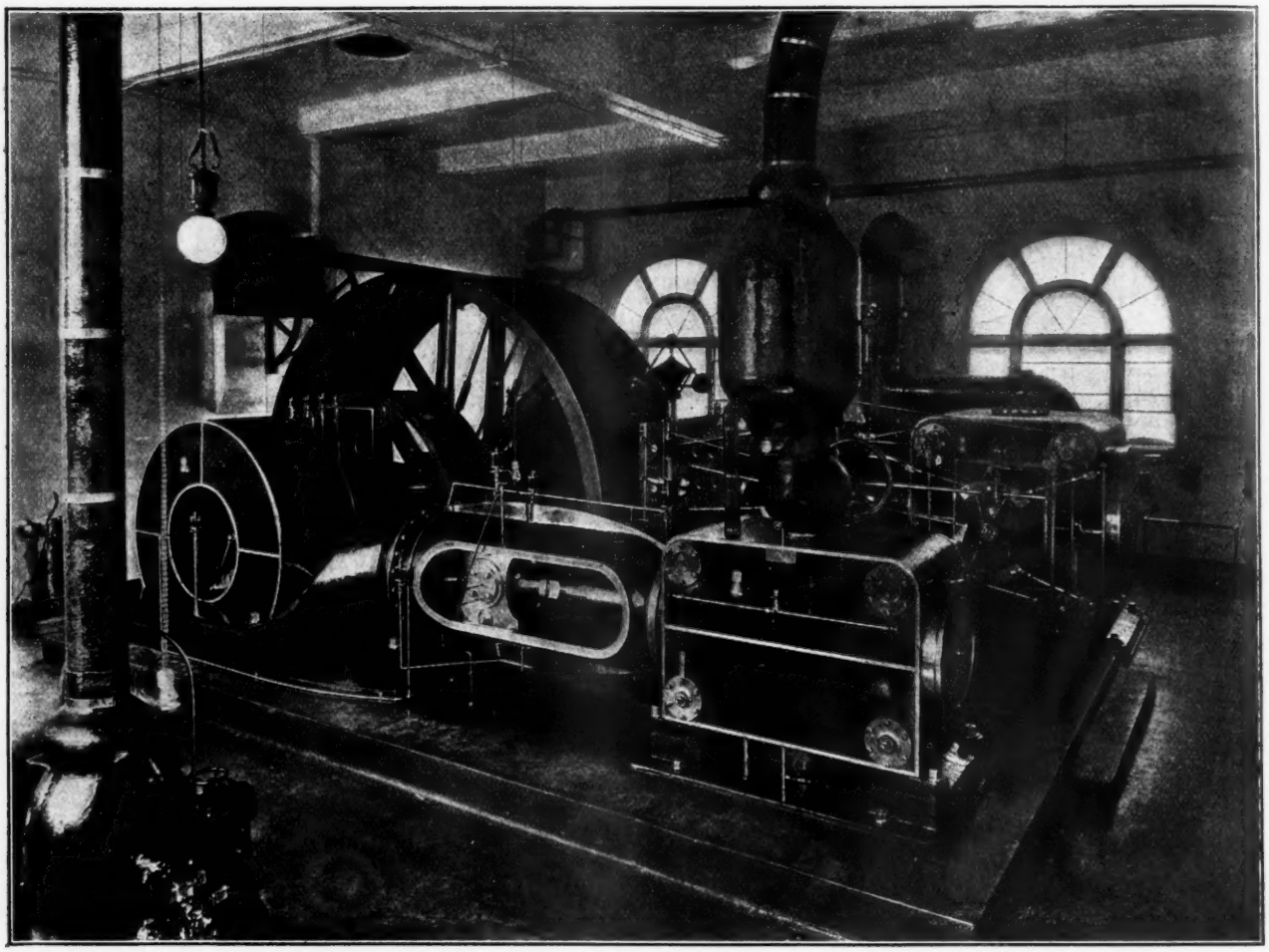
Twin City CORLISS ENGINE



Large Cross Compound Twin City Corliss Engine running one of the largest Flour Mills in Minneapolis. 18 ft. fly wheel grooved for 24 2-in. ropes.

All auxiliaries driven by belt from main engine giving greatest possible economy in steam consumption.

Brochure No. 101 sent on application.

MINNEAPOLIS STEEL AND MACHINERY CO MINNEAPOLIS

Oil Cups
Are Always Hungry

and they demand incessant attention—but there's none of that annoyance or expense in plants that use

KEYSTONE GREASE

It lasts 50 times as long as oil, lubricates better while it lasts, does not spatter, melt or run away and never gums up or clogs bearings.

"KEYSTONE" reduces friction so effectively that a saving of 25 to 75% in power is sure to result. It is as efficient in cold weather as in hot.

Let us send you our booklet, "GREASE vs. OIL." It's free.

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TRADE MARK
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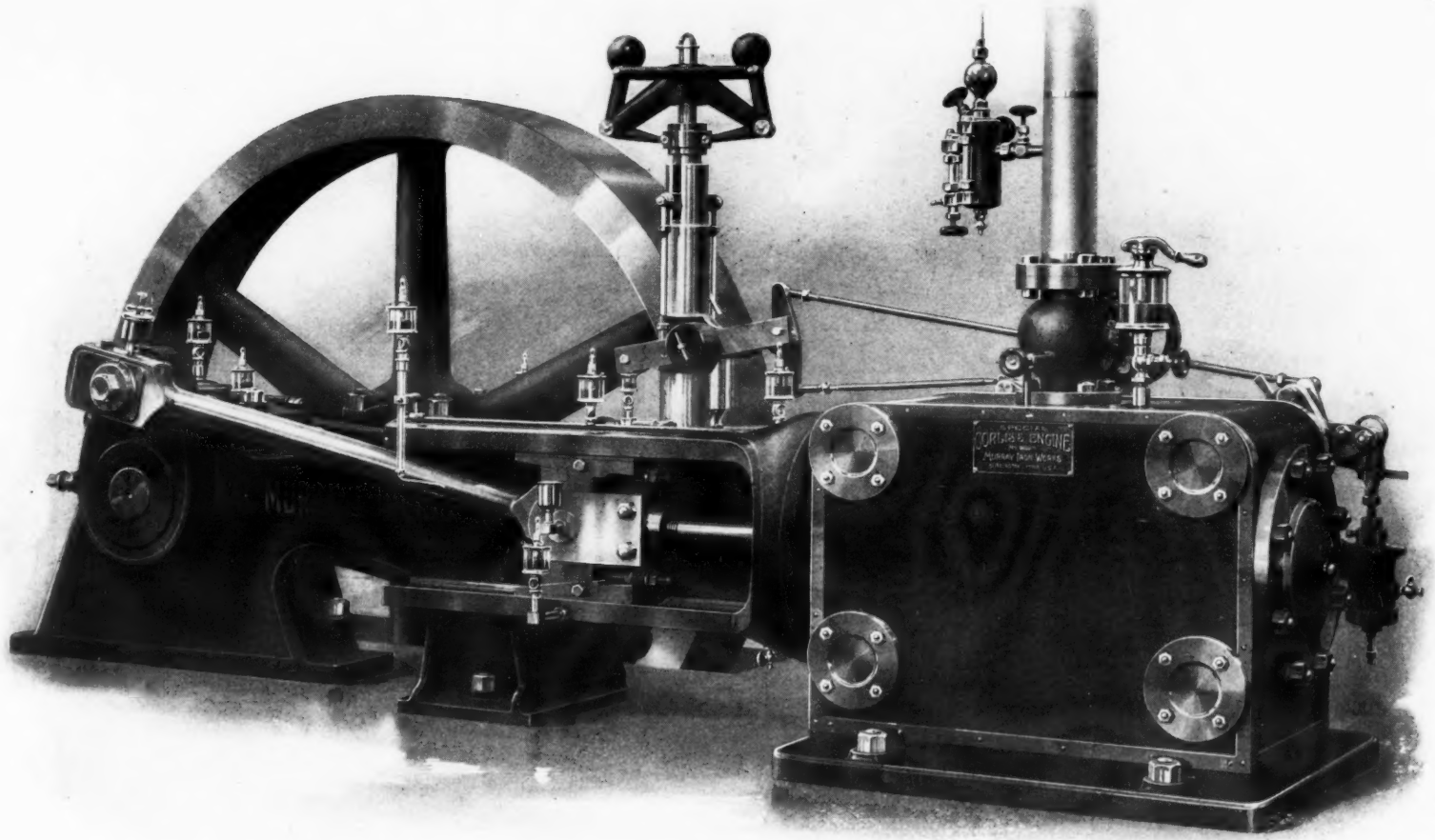
This Is The New Small Corliss Engine

25 to 50 H.P. **It Will Save Half of Your Coal Bill**



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MURRAY IRON WORKS COMPANY
Incorporated February 1--1870
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Water-Tube Boilers